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Research on Illumination

IN our last issue we made some general observations on the Free Report issued by the Department for Scientific and Industrial Research, giving a preliminary survey of the work of the Illumination Research Committee, and to Mr. Walsh's paper on this subject read before the Illuminating Engineering Society on June 1st.

In the present issue we reproduce (pp. 193-200) Mr. Walsh's paper and the ensuing discussion. Last month we dealt mainly with the constitution and methods of work of the Illumination Research Committee, pointing out its very representative character and its interlinking with all the other chief bodies and committees concerned with illumination. We are glad to observe that since the reading of Mr. Walsh's paper, and the issue of the Report, numerous references to the work of the Illumination Research Committee have appeared in the daily and technical press.

Let us turn now to some of the actual researches in progress. These may be divided into "fundamental problems" and "practical problems of urgency," the former naturally requiring somewhat prolonged research, the latter mainly capable of fairly quick solution. "Glare" formed the subject of the very first discussion before the Society in 1909, and it has been dealt with repeatedly since. During these eighteen years considerable progress has been made. We have now a much clearer conception of the origin of glare and the various ways in which it affects us in daily life. We have devised simple rules which, though empirical and based on experience rather than deep scientific research, go a long way towards eliminating the drawbacks of glare in practice. At the same time makers of lamps and lighting appliances have shown themselves active in devising means of avoiding glare, so that to-day the consumer has plenty of efficient shading devices available—a condition that was certainly not realized in 1908! Further, as a result of the educational work that has been done, the conception that glare is a handicap has become much more familiar to the community. Though there are still too many instances of glare to be seen both in streets and interiors, it cannot be denied that substantial progress towards its elimination in practice has also been made. Moreover, the effects of glare and excessive contrast are now much more acutely realized. We are constantly finding out new ways in which such effects diminish efficiency or act as a source of danger—the instance of the effect of passing through short tunnels on the eyes of drivers of railway trains, mentioned by Mr. Cunnington, is a case in point. These discoveries are the result of practical experience. We still need, however, further scientific analysis of the basis of glare, which is largely a physiological problem, and a ready test by which the existence of glare may be quickly determined. This is the kind of information that the experiments being conducted by the Illumination Research Committee may ultimately furnish.

In all such cases it is only when we come to investigate a problem that its full ramifications are appreciated. What may at first seem to be a simple matter turns out to be a complex one. The same applies to another fundamental research now being conducted, i.e., that relating to the effect on illumination on speed and efficiency of work. Here, however, we have one manifest advantage. We have now available serviceable instruments by which illumination can be measured and correlated with data on output and efficiency. Without the illumination-photometer the effect of illumination on speed of work would have been mainly conjectural. Thanks to this instrument we have already a good working knowledge of the order of illumination found in factories, and several useful investigations on the relation between illumination and speed of work have already been made. In this country a considerable amount of attention has recently been devoted to the lighting requirements in public offices, and especially in post office work. We may also recall the researches of the United States Public Health Service in connection with American post offices, the results of which were communicated to this journal by Dr. J. E. Ives last year.* We have received another contribution from Dr. Ives, which we propose to deal with in our next number. An interesting feature of this work is the analysis of industrial operations in terms of the period of time for which the eye is respectively active and quiescent, and the derivation of a general formula by which (introducing suitable constants) the relation between illumination and production for any particular process may be expressed.

It is evident that though the general nature of the relation may be broadly similar, the presumed limiting illumination, beyond which further increases in illumination have no economically material influence in improving production, will vary much for different processes. The relation is best studied by the examination of "fine work" where the influence of illumination is most apparent. The Illumination Research Committee therefore acted wisely in selecting printing as one of the first processes to be examined. It is hoped that the report of this investigation will be available shortly, but meantime it is understood that the importance of good illumination has been amply justified. The Committee was fortunate in receiving the co-operation of the Joint Industrial Council for the Printing

* *The Illuminating Engineer*, Vol. xviii, pp. 98, 211.

Trades of this country. In any research of this nature the aid of those with practical experience of an industry is essential in order to guard against misinterpretation of production-results, and ensure the carrying out of tests on a basis applicable to practical conditions. The research, it is hoped, will be extended to other industrial processes. It is manifestly of the greatest importance to the lighting industry, as well as the public.

Of the numerous other problems mentioned special interest attaches to those dealing with daylight illumination, and the effect of colour and distribution on the degree of illumination required for comfortable work. At the National Physical Laboratory last month the arrangements for testing the effect of artificial daylight, for example by means of artificial windows, transmitted light from "daylight" lamps, were on view. (We may mention incidentally that some visitors had difficulty in finding anyone to demonstrate this experiment, and it was apt to be overlooked. Whilst making full allowance for the great demands on the staff of the National Physical Laboratory during the annual visit, we think it would have been well to have in attendance a special demonstrator for this interesting experiment.) The experiments on the effect of flickering illumination, the brightness of illumination fittings, and the cut-off angle of industrial reflectors are likewise of a very practical nature—the latter an investigation which is supplementary to the work of the B.E.S.A. committees. Other experiments are being made on the design of picture galleries so as to avoid troublesome reflections from the glazed surfaces of pictures, the transmission of window glass, and problems relating to access of daylight.

Lastly we may mention the drafting of a concise explanation of technical terms used in illumination. As mentioned in Mr. Walsh's paper, a special point is being made of the definition of terms of interest both to lighting experts and physiologists. The work of framing definitions intelligible and acceptable to both varieties of experts is very important in paving the way for future joint work and bringing about a common understanding in illumination.

We should also like to refer to the very valuable "British Standard Glossary of Terms Used in Electrical Engineering," now issued by the British Engineering Standards Committee. This is a most comprehensive and useful piece of work. Readers will be interested in the series of definitions of terms used in illumination, incorporated therein. This is brought up to date by the inclusion of a number of supplementary terms rendered necessary by recent developments in illuminating engineering.

Illuminating Engineering: Its Value to the Electrical Contractor

ON the occasion of the first annual Conference of the Electrical Contractors' Association, held in Brighton last month, several important topics were discussed. The problem of training was dealt with both in Mr. T. E. Algar's Presidential Address and in the paper on "Apprenticeship" by Mr. Walter Riggs. Mr. Frank Purse explained the procedure of the National Register of Electrical Installation Contractors. Mr. Ll. B. Atkinson spoke on the Need for Standard Wiring Rules; and Mr. Walter Finlay outlined the basis of co-operation between supply undertakings and contractors.

Everyone must view with sympathy the desire to raise the status of the contractor, and the scheme of the National Register has undoubtedly been helpful in this direction. Status, however, is clearly largely a matter of training and education, and it would seem that the facilities for training are not quite as complete as one could wish. Reference was made to the valuable educational work of the City and Guilds of London Institute, but, as remarked by the writer, the syllabus does not include detailed instruction in illumination. Hitherto the education of contractors has been concentrated mainly on wiring and equipment details, while the broader aspects of their work have been somewhat overlooked.

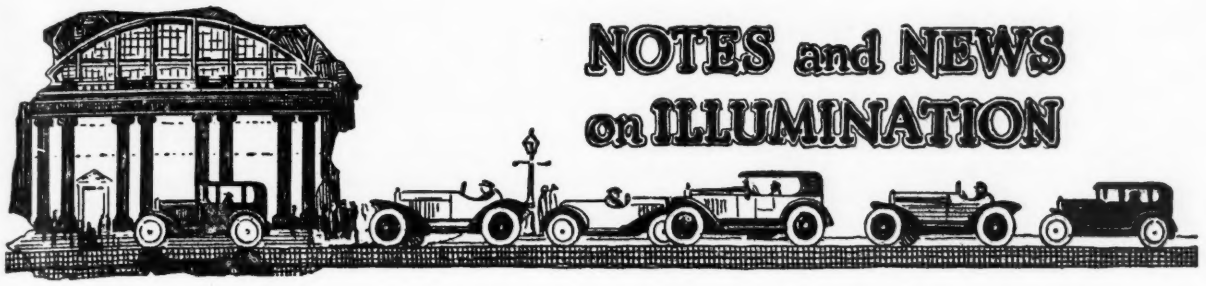
The lack of a liberal education in this and other directions has been one obstacle to participation in schemes of common interest. As an example of co-operation Mr. J. W. Beauchamp referred to the prospective autumn joint scheme of propaganda by the E.D.A. and E.L.M.A. on domestic applications of electricity, in which the lighting of the home will play an important part. Lighting still forms the backbone of the electrical supply business, and is a matter with which contractors are mainly concerned. The carrying out of lighting schemes rests mainly in their hands, and it is of vital importance that they should be familiar with the latest developments in illuminating engineering. We hope, therefore, that at the next Conference illumination and the co-operation of contractors in concerted schemes for arousing public interest in the benefits of good lighting will form one of the main topics for discussion. We may add that we shall be glad to give what aid we can to this important educational campaign.

The Study of Colour

IN our May issue we gave a general review of the papers read at the Optical Convention, and in this issue we are supplementing the account by an abstract of the very comprehensive paper read by Mr. J. Guild on Colorimetry. Mr. Guild recalls the very valuable pioneering work of Sir William Abney and Professor Watson. It is doubtless true that a distinct gap has been left by the death of both these workers, and that few people in this country have since had the knowledge, leisure and facilities to pursue the study of colour in the same way.

Mr. Guild succeeded in showing the very wide range of the subject, and the large amount of "fundamental research" still to be done in this field, where physical and physiological phenomena are so closely related. Since the days of Sir William Abney an impetus has been given to the subject by the develoments in electric incandescent lamps, and the practical bearing thus given to researches on radiation. In the same way the development of the textile and dyeing industries and the formation of their research councils has led to a closer study of spectrophotometry and systems of colour nomenclature. Whilst many attempts to frame a systematic system of colour nomenclature have been made, agreement on a standard system for industries interested in colour has not yet been attained. To dyers and colourists, paint merchants and other trades, it would be of immense benefit if a universal system of colour nomenclature could be evolved. At present everyone is aware of the possibilities of misunderstanding when exact shades of colour have to be specified. Ultimately, perhaps, this is a field where the B.E.S.A. could exercise its beneficent influence.

The problem is, however, a complex one. The appearance of colours does not depend only on their own attributes. In order to specify and reproduce the impression made by a coloured fabric we must also standardize the intensity and quality of light by which it is illuminated. There is also the fact that the impression may vary according to the portion of the retina of the eye on which the image of this coloured object is received. The problem is thus a difficult one, though not insuperable.



The Electrical Contractors' Convention

The first annual convention of the electrical contractors, which took place at Brighton last month, was quite successful. The Presidential address by Mr. T. E. Alger contained a survey of the growth and development of the Association and referred to the National Register of Electrical Installation Contractors, as destined to play an important part in raising the status of the electrical contractor. Mr. Finlay's paper on "Co-operation between Electricity Suppliers and Contractors" gave rise to a good discussion, opened by Mr. J. W. Beauchamp, who outlined the E.D.S. autumn campaign on "Wiring the Homes of Great Britain." In this work the E.L.M.A. is actively co-operating. Mr. Walter Riggs's paper on apprenticeship also led to numerous interesting points being raised. Mr. W. R. Rawlings paid a well-merited tribute to the valuable educational work of the City and Guilds of London Institute. Mr. Leon Gaster urged the need for education in lighting matters, and we hope that at the E.C.A. meeting, to be held in Scarborough next year, illumination will play a more important rôle.

Ophthalmological Society

At the recent annual congress of the Ophthalmological Society papers were mainly of a professional character, but there were several, such as Professor Roaf's "Observations on Colour Vision" and Mr. C. Goulden's contribution on the ultra-violet treatment of certain eye diseases, that deserve notice. Apparently in some cases the results of such treatment are hopeful—which shows once more that ultra-violet rays are no longer to be regarded with horror as inevitably a menace to eyesight, but as contributory to health if wisely used and only dangerous when misapplied. An able address by the President, Sir John Herbert Parsons, dwelt on the danger of over-specialization and advocated research on wider lines, so as to correlate ophthalmology with other fields of knowledge. This is in line with Sir John's remarks when presiding at the recent discussion of Mr. Walsh's paper on research at the last meeting of the Illuminating Engineering Society. An apt illustration of the tendency to broadening of research was provided by the subsequent visit of the ophthalmologists to the National Physical Laboratory, where much interest was shown in the physical and engineering researches going on.

Reflections from Glazed Surfaces in Picture Galleries

A visit to the Royal Academy during the recent sunny weather afforded a good opportunity of studying the troublesome problem of reflections from the glazed surfaces of pictures,—a problem which is being investigated by the Committee on Illumination working under the Department for Scientific and Industrial Research. The overhead illumination from skylights at Burlington House gives excellent illumination, and the arrangement of pendant canvas screens under the skylights, the inclination of which can be altered, is doubtless an aid towards the avoidance of these reflections. A striking point is the difference between pictures which have glass and those without. In the latter case the writer noticed practically no troublesome reflections; in the case of the former the reflected images of persons in the room were sometimes inconvenient, especially in the case of dark canvases. The direct reflection of skylights themselves in the glass of pictures has been mentioned as a very serious defect, but it would appear that with ordinary care this can be avoided. At any rate the writer saw no sign of it at the Royal Academy. But the difficulty of images of people in the rooms, especially in the summer when light-coloured garments are worn by many visitors, is much less easily overcome. It may be recalled that in the course of a discussion before the Illuminating Engineering Society shortly before the war Mr. Joseph Pennell contended that the trouble could only be avoided by concentrating the light on the pictures and leaving the centre of the room, occupied by visitors, in semi-darkness. In practice this idea could not be followed out very closely without a radical change in picture galleries as at present designed. If pictures are flooded with light a considerable amount must necessarily stray into the centre of the room, though no doubt the trouble can be alleviated by partial restriction of the area lighted. It is also recognized that subdued lighting of the area occupied by visitors would not be popular, as visits to picture galleries are to some extent social events and people like to see each other. Tilting the pictures has also been suggested as a partial remedy. Whilst it is recognized that very valuable masterpieces on permanent exhibit may need glass protection, it may be suggested that in general artists whose work is on view for a relatively short period might make a practice of dispensing with glass, as is quite usual with oil paintings.

Short or Long Wave Ultra-Violet Radiation?

THE BIOLOGICAL ZONE OF THE SPECTRUM.

A question that goes to the very root of "artificial sunlight" treatment is the effect of the various regions of the spectrum. A great variety of lamps—mercury vapour lamps with quartz tubes, arcs between carbon, tungsten or impregnated electrodes, etc.—is available, and their relative value is the subject of much discussion. It is therefore necessary to have a clear idea of the effects of the various forms of radiation emitted.

Since the beginning ultra-violet therapy rays have been divided into two groups, the "long wavelengths" (4000-3,000$\mu\mu$) and the "short wavelengths" (from 3,000-2,000$\mu\mu$), the latter being considered to differ from the former in the fact that they alone cause irritation of the skin.

According to an article contributed by Dr. Kurt Huldschinsky of Charlottenburg to *Modern Sunlight*, this grouping is quite wrong. He contends that only a very narrow range of wavelengths cause skin-irritation i.e., *those between* 3,100 *and* 2,800$\mu\mu$. These waves are stopped by ordinary glass. Waves longer than the above pass through a 0·1 mm. thick cutaneous layer. Waves shorter than the above are absorbed in the outermost layer of the epidermis, so that no material reaction occurs.

According to the author this fact explains many discrepancies in the action of different forms of lamps. If it is indeed true that only this narrow range of rays is biologically active, it would clearly simplify matters if existing sources were provided with suitable filters so that only these rays are transmitted. However, Dr. Huldschinsky's hypothesis seems to require confirmation. It is necessary to know all about possible effects of other parts of the spectrum and especially to determine whether the longer wavelengths do not play a secondary part when mixed with the admittedly "active" rays, as some authorities have contended.

The Lighting of Newspaper Printing Works and Offices

The Electrician, in a recent leading article on "Illumination Research," refers in appreciatory terms to the work being conducted by the Illumination Research Committee operating under the Department for Scientific and Industrial Research. The investigation on "glare" is regarded as amongst the most important, but naturally the research on the lighting of printing works is also singled out for special attention. In this connection the Editor puts in a word for the editorial staff. Readers' boxes in particular need good lighting, in view of the closeness of the work, which puts a somewhat severe tax on the eyes. This matter might be studied with advantage by proprietors of newspapers, especially technical journals, to whom the need for good lighting should make a special appeal. We fear there are still many premises where admirable scientific and technical information is brought into circulation under somewhat disadvantageous circumstances as regards lighting!

Messrs. Benn Bros. Ltd.

Opening of New Premises

Incidentally we may mention that Messrs. Benn Bros. Ltd., in their fine new premises (whence *The Electrician* emanates), have evidently not lost sight of lighting requirements. The offices strike one as being well provided for in regard to daylight, admission of which is assisted by the white-tiling of some of the external surfaces. Artificial lighting is also on a generous scale, a feature being the use of diffusing units mounted direct on the ceiling, in some cases supplemented by local lamps. The new offices were opened on July 8th when visitors entertained by Sir Ernest Benn and his co-directors had an opportunity of judging for themselves the nature of the improved accommodation now available.

Domestic Gas Lighting at Leicester

A feature of the recent Health Exhibition at Leicester was the Gas Exhibit, supported by a number of leading manufacturers as well as the Leicester Gas Department. Whilst much attention was paid to heating and cooking appliances, gas lighting was not overlooked. Amongst the exhibits was a dwelling-room lighted by a semi-indirect central pendant, a drawing-room illuminated by pleasing shaded lamps, and a demonstration window ("Abolish Smoke Clouds with Gas") which received exterior lighting by gas lamps equipped with inclined parabolic reflectors.

Eyeshades in Lawn Tennis

The chief impression carried away by a visitor to Wimbledon during the brilliant sunshine that prevailed during the great tournament at the end of June was the exceptional brightness of the sunlight. The great majority of the events must have been played in full direct sunshine, and ample light for play was available up to a later time in the evening than usual. It is not surprising to find therefore that the wearing of an eyeshade has become more popular than ever. This is not merely a fashion, like the "bandeau" introduced by the great Suzanne. The eyeshade has practical utility, both in screening the eyes from the direct rays of the sun and the bright expanse of overhead sky, and also, probably, in limiting the field of view and aiding concentration on the ball. It is also to be expected that, apart from its influence on accuracy of play, the wearing of the shade is also an aid to the eyes, which are apt to become fatigued or irritated after prolonged play in bright sunshine. In dwelling on the beneficent effects of sunlight on health one must not forget that in this country long spells of brilliant sunshine are the exception and our eyes therefore need to become acclimatized. Nature has provided the Arabs with dark lashes to screen their eyes from the intense sun of the desert, and and it is probable that the retinæ of people living in tropical districts become habituated to continuous bright light much more intense than that found in northern latitudes. The wearing of an eyeshade is an old dodge of draughtsmen, engravers and others engaged on fine work. It is somewhat surprising that it has only recently been introduced in athletics. Players on artificially lighted courts, where the great difficulty of avoiding glare from overhead lighting units is well known, might also benefit from this simple device.

The Universal Smoke Abatement Exhibition

From the point of view both of industry and national health the opening of the Universal Smoke Abatement Exhibition at Birmingham in the early autumn will attract attention. The aim of the promoters is to stimulate interest in the means of obtaining efficient combustion, effective utilization of heat, the maximum extraction of valuable contents of fuels and the development of practical alternatives. A full realization of these means, it is believed, will lead ultimately to the elimination of unnecessary waste and labour in the office, house and works.

The Exhibition will be divided into two main sections —industrial and domestic. The industrial section will deal with steam generation, power generation, heat production, and electro-chemical exhibits. The domestic section will endeavour to bring home to the housewife the many modern systems and appliances which so greatly lessen the cost and burden of work in the home.

The exhibits will deal with heating, cooking, hot water and ventilation, stoves, fires, ranges, cookers, etc., and will afford every housewife an opportunity of becoming acquainted with the latest improvements in labour-saving devices in the kitchen. She will be able to see how gas-stoves can be controlled to give the required amount of heat and no more, how the smokeless fires will result in less spring-cleaning, and a thousand and one other devices ensuring economy by simplifying labour and avoiding waste and dirt.

The British Standard Glossary of Terms Used in Illuminating Engineering

One of the very first steps to international exchange of views, indeed any continuous intercourse between men of science and engineers, is agreement on common terms and definitions. We therefore welcome the appearance of the "British Standard Glossary of Terms Used in Electrical Engineering" now issued by the British Engineering Standards Association (B.E.S.A. Specification No. 205/1926).* This represents the results of a great deal of hard work and co-operative effort on the part of a wide circle of committees and engineers. Literally hundreds of people had to be consulted and the Editing Committee, consisting of Lt.-Col. K. Edgcumbe and Mr. C. C. Wharton, must have had an enormous task. The electrical industry owes them a debt of gratitude for their unremitting efforts.

The bound volume of the Glossary contains over 250 pages and the alphabetical index alone requires about 50 pages. As some thousands of terms are dealt with the value of this index, facilitating quick determination of the whereabouts of each term and the section under which it is classified, is evident. The Glossary is divided into eleven main sections. Terms used in illuminating engineering are included in the lighting, heating and domestic appliances section. This is now quite a comprehensive list, including many recently introduced terms, such as the "angle of cut-off" as applied to reflectors, which is not yet widely familiar, though a most important term.

We are glad to note that the Glossary has been adopted by the International Electrotechnical Commission as the basis for the arrangement of an International Glossary now in course of preparation.

* Obtainable from the B.E.S.A. Publications Department, 28, Victoria Street, London, S.W.1; price 5/6 post free.

A Shop-Window Lighting Campaign in Germany

Shop-window lighting, which was the subject of an energetic campaign in this country last year, is now being actively taken up by Germany. As a result of the conference of electric supply undertakings in Berlin last month it was decided to embark on wide propaganda, including educational work on show-window lighting, the offering of prizes and articles in the press.

The first section of these activities will be opened by a course on illumination for electrical contractors, having special reference to shop-lighting, to take place during July and August. At the end of the latter month electrical undertakings will begin to distribute literature on illumination to bodies concerned with shop-windows. These leaflets will outline ten main principles of window-lighting, and will be illustrated by sketches. During September and subsequent months contractors will take up the work by circularizing merchants in their localities.

The competition for prizes is to take place in December, replies being invited to various queries; two windows, one large and one small, to be described as good examples in terms of brightness of illumination, absence of glare, good distribution of light, and shadow effects. Solutions are to be sent in by December 24th. Prizes will be awarded for the best solutions. There will also be special prizes for schoolchildren and the medals awarded to the contractors responsible for a certain number of windows, selected as the best sent in.

The competition will be preceded by widespread publicity in the press with the object of making it widely known.

It is interesting to observe this additional instance of the the activity in illuminating engineering abroad, and the determination to bring before the public the essentials of good lighting.

A Luminous "Liberty Bell"

According to *The Electrical World* the opening of the Sesqui-Centenniel Exposition at Philadelphia on Memorial Day was marked by novel forms of spectacular lighting, such as the "Liberty Bell" erected at the entrance to the grounds. Reaching 80 ft. above the sidewalk this replica of the historic bell contains more than 25,000 15-watt lamps in various colours. When lighted up the bell can be seen from practically every vantage point in Philadelphia, and is said to be visible 50 miles away. Other lighting schemes were devised. The Philadelphia City Hall is being floodlighted in a colour scheme of red, blue, and deep purple, and the famous statue of William Penn on the apex of the tower is being illuminated by four 1,500,000-candle searchlights. There is also a tower of light, visible from afar as a lofty silver shaft and 200 ft. high. For other colour-flood-lighting effects 24 searchlights with a combined candle-power of 10,800,000,000 will be used. Evidently spectacular lighting is practised in the United States on a generous scale.

It will be noted that a special feature of much of the floodlighting is the use of coloured light. This is in accord with modern practice in exhibition lighting where the general use of "white" floodlights is apt to give a somewhat cold and ghostly effect, though its use in certain cases may be recommended to give an effect of dignity and restraint.

Caution Necessary in Handling Radioactive Material

The need for caution in dealing with new forms of radiation has been emphasized only too clearly by the sufferings of pioneering workers in these fields, notably by those responsible for the development of Röntgen rays. Excess of ultra-violet energy has also potential dangers, and the skin trouble apt to be caused by the injudicious handling of radioactive materials is well known. The danger in such cases is accentuated by the fact that the injurious effect, slight at first, may be cumulative, so that in many cases it is difficult to stay the progressive advance of the trouble once it has commenced. A contribution by Messrs. Martland, Conlon, and Knef to *The Journal of the American Medical Association* draws attention to some unrecognized dangers in the handling of radioactive substances, such as those commonly used in the preparation of luminous dials for watches, etc. It would seem at first sight that the amount of energy here involved is so small that serious danger to health is precluded, for the proportion of radio-active material in the luminous mixtures applied in such work is minute. Nevertheless, several cases, one of them fatal, of poisoning amongst workers with these materials are recorded. It was found that the women employed habitually licked the paint brush, and so absorbed small quantities of radioactive substance, leading to disease of the jaw, anæmia, etc. The anæmia is due to the ingestion of radioactive elements and the consequent emission of irritative rays which in time exhaust the blood-forming organs. Unfortunately once radioactive elements have been deposited in the body there is no known way of eliminating, changing, or neutralizing them. This shows the need for scrupulous care in handling radioactive material, and also the danger of any speculative treatment based on the administration of medicine containing traces, even if minute, of radio-active salts.

Electric Incubators

In the *Electrical World* H. H. Dunn describes the working of an electric incubator capable of hatching 3,000,000 chicks yearly. Electricity maintains heat at 103°, turns the eggs over six times every 24 hours, and starts illumination of the entire plant promptly at six o'clock every evening. It also drops the door to each compartment at the end of the 21st day so that the hatched chicks may have light and air, and then turns on the heat in the huge brooders, to which 560,000 chicks of each setting are transferred.

Upon reaching the incubator the eggs are passed, one at a time, before an electric testing lamp. Unfertile eggs are eliminated by this "egg X-ray" method and are sold to bakers and other large consumers. This use of light to determine whether eggs are fertile or not is particularly interesting.

Electrical Developments in Roumania

According to accounts received electrical developments are now proceeding rapidly in Roumania. The first hydro-electric installation, of 1250 k.v.a. at Sinaia, was made in 1899. Numerous larger plants have since been added, and this year a 60,000 v. line connecting Sinaia and Brassov will be completed. Surveys of hydro-electric sites have been conducted during the past three months, and the water power resources of the country

are estimated to exceed 1,000,000 k.w. Electricity is now becoming widely used for power purposes in the mining districts. Electrification may be expected to proceed rapidly during the next few years, when the use of electric lighting, in place of the oil lamps almost invariably used except in the cities, will doubtless become much more general.

Demonstrations of Illumination at Toronto University

At Toronto University, where a general course on illuminating engineering has been given for some years, a new departure—the organization of a Lighting Demonstration Room—is now in hand. This is intended to serve both as a laboratory for students and as an exhibit open to the general public, who, it is suggested, will appreciate this opportunity of examining the latest forms of lighting fittings without being in any way pressed to make purchases. Typical methods of lighting, good and bad arrangements, and up-to-date lighting fittings for the home are to be on view, and exhibits will be explained with the aid of tests with illumination-photometers. Similarly the effect of artificial daylight units will be shown with the aid of the colorimeter. This new departure is receiving support from leading manufacturers. We understand that a similar demonstration room has been in existence for some years at the Massachusetts Institute of Technology, Boston.

The Lighting of Steam Locomotives

A contribution by H. Jacobi to the *A.E.G. Mitteilungen* describes what seems to be a novel departure in train lighting—the use of a special small turbo-dynamo, mounted direct on the locomotive. The idea of driving a small dynamo from one of the axles is of course familiar, but in this case a turbo-dynamo driven by the steam of the engine is used. This can be mounted in a convenient position at the side of the engine, and is thus readily accessible. The generator is of 0·5 kw. capacity, operates at 32 volts, and weighs 75 kg. Machines working at 24 volts, so as to be in line with standard practice, have since been introduced. The dynamo supplies the headlights of the locomotive, and also affords current for the illumination of the driver's cab, thus fulfilling the same functions as the dynamo of a motor-car. There is also a special arrangement of concealed lights to illuminate the water-gauges, so as to enable the exact level of water to be clearly seen.

Luminous Automatic Signalling on the French Railways

In *Science et la Vie* Monsieur J. Marchand contributes a description of the new system of signalling with coloured bull's-eyes, which is being introduced on the French railways. The signals are electrically lighted and conveyed entirely by changes or combinations of colours. The method has proved quite satisfactory and has evident advantages, for instance the identical appearance of signals by night and day, the greater visibility, and the readiness with which the system can be made automatic, as there are no moving parts. The system has been installed on the Paris-Versailles line and other sections, and is likely to be considerably extended.

The "After-Glow" of Electric Lamps

Although the metal filaments of modern incandescent lamps cool much more rapidly than the old carbon filaments, and likewise attain their brilliancy on being switched on more rapidly, the effect is not instantaneous. The question is of importance in connection with electric motion-signs, many of which would be impracticable with carbon-filament lamps, and are only rendered possible by the rapidity with which metal filaments attain full brilliancy and lose their light. The period necessary for the "after-glow" of a metal filament to cease after being switched off has been studied by Hg. Frühling, and is described in an article contributed to *Licht und Lampe*. The time necessary for the light to become inappreciable naturally varies with different types of lamps, but it appears that in every case the period was less than half a second. As the curves connecting light and time are logarithmic, the practical "extinction period" would, however, be very much less than this. One of the few sources that light up and cease to give light instantaneously is the neon lamp, and it is this quality that renders it so useful in stroboscopic researches.

The Effect of Polarized Light on Plants

In *The Scientific American* Professor Sheldon describes the procedure necessary in testing the comparative effects of ordinary and polarized light on plants. The conception that polarized light exerts a special influence has apparently been verified by Miss E. S. Semmens, an English botanist, whose curiosity was aroused by the conviction of an old gardener that seeds germinate more quickly at the period when there is a full moon. As moonlight is of such very weak intensity in comparison with sunlight its effect in this respect is rather a mystery. The explanation offered is that moonlight is about 10 per cent. polarized. Subsequent tests are stated to have shown that polarized light is apparently more active than ordinary light in hastening germination and the development of flowering plants. There are quite a number of processes that are popularly believed to be associated with the full moon, and the suggestion is thrown out that in some of these cases the fact of the light being polarized may be of importance. One curious observation mentioned is that sea-urchins found in the Red Sea have been observed to increase in size during the period of the full moon.

Projection from the Microscope

In the case of all scientific apparatus a distinction has to be drawn between cases in which the instrument serves only for the needs of an individual investigator and those in which it is desired to exhibit results to an audience. For example, most photometers, having an eye-piece, are designed for individual use, though there are some which can be observed by several people simultaneously. It is, in fact, something of a drawback for the experimenter to have his eye continually glued to a telescope, and it is a great relief to be able to view phenomena at a fair distance and on a larger scale. Similar considerations apply to the microscope. It is, therefore, of interest to note in *The Elektrotechnische Zeitschrift* a description by F. Brautigam of an apparatus which enables the object seen in the microscope to be projected on to a screen in a darkened room. It is suggested that this will be useful in many researches where the microscope acts as a control and has to be used almost continuously. It would, for instance, be helpful in studies of the structure of filaments of incandescent lamps. The accessory projector is simple in character, and uses a metal-filament focus lamp with concentrated filament, which, with a little adjustment, can readily be run off the ordinary supply.

Are Stars Visible in the Daytime?

In *The Scientific American* Professor C. C. Wylie revives an old controversy—whether stars are at any time visible during the day. People may be found, sea-captains for instance, who affirm that they have occasionally seen bright stars in full daylight, but experts believe that this is impossible, though conceivably *planets* might occasionally be observed in this way. It is common knowledge that Venus can often be seen long after sunrise, and also in the early evening when the sun is still comparatively high in the heavens. It is conceivable that under favourable conditions it might even be seen in full daylight, but it seems highly improbable that *stars* could be seen. Professor Wylie recalls the old idea that stars can, nevertheless, be seen at mid-day by a person looking upwards from the bottom of a mine shaft or pit in the earth. From a consideration of the behaviour of the human eye, it is difficult to understand why, in these circumstances, stars should be seen with greater ease. The degree of contrast between the star and the adjacent sky is the same, whether viewed from the bottom of a pit or from the earth's surface. Professor Wylie, at any rate, is frankly sceptical.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Research in Illumination

(Proceedings at the meeting of the Illuminating Engineering Society held at the House of the Royal Society of Arts, 18, John Street, Adelphi, London, W.C., at 7 p.m. on Tuesday, June 1st, 1926.)

A MEETING of the Illuminating Engineering Society was held at the House of the Royal Society of Arts (18, John Street, Adelphi, London, W.C.), at 7 p.m., on Tuesday, June 1st, 1926, Sir J. Herbert Parsons, D.Sc., F.R.C.S., F.R.S. (Past President) presiding.

The minutes of the last meeting having been read, the Hon. Secretary read out the names of the following applicants for membership:—

Members:—

Goddard, A. C.....Electrical Engineer, Messrs. J. Lyons & Co. Ltd., Cadby Hall, Kensington, London, W.

Porri, A. G.....Architect, 37A, Finsbury Square, London, E.C.2.

Porter, Major E. G. ....Illuminating Engineer, 15, Christian Road, St. John's Hill, London, S.W.11.

Associates:—

Atherton, C. A. .....Head of the Development Department, Phœbus S.A., Rotisserie, 2, Geneva.

The names of applicants announced at the last meeting were read again, and these gentlemen were formally declared members of the Society.*

The CHAIRMAN then called upon Mr. J. W. T. Walsh to read his paper, which was as follows:—

Research in Illumination, with particular reference to the work of the Illumination Research Committee of the Department of Scientific and Industrial Research

By JOHN W. T. WALSH, M.A., M.Sc., F.Inst.P., A.M.I.E.E.

(1) *Introductory.*—Although it is true that illuminating engineering is one of the youngest branches of applied science, it is probably not too much to say that every illuminating engineer has, at one time or another, been surprised at the very limited extent of our knowledge of the subject, and has become painfully aware of the enormous extent of fruitful ground which awaits the research worker in this particular field of scientific endeavour.

The reason for this, however, quickly becomes apparent as soon as any particular problem is attacked, for it is then realized how tremendous is the task that the illuminating engineer has before him. The civil, the mechanical, and the electrical engineer have to deal with phenomena which are almost entirely physical in character. The properties of materials and their action on one another are the only matters of importance, and it is only the heating and ventilating engineer whose work approaches in any degree to that of the illuminating engineer in demanding an understanding of the physiological behaviour of the human body.

The final judge of the work of every illuminating engineer is the human eye, and it is the eye, first and foremost, which he must consider in everything that he does. "What will the eye think of it?" is the paramount question, and it is, therefore, not too much to say that the study of the properties of the eye under different lighting conditions and the study of the properties of illuminants are at least of equal importance to the progress of illumination as a science, and, in fact, one is of little value without the other. This may sound an exaggerated statement to those whose training has naturally led them to regard engineering as the application to daily life of the discoveries of physical science, but, in the writer's opinion, the time has now arrived when the engineer who is specializing in illumination must regard physiology, or at any rate ophthalmology, as a subject with which he requires more than a nodding acquaintance if his work is to be other than a mere blind application of charts and schedules. If this is true of the practising illuminating engineer, with how much the greater force does it apply to anyone who has, one might almost say the temerity, to undertake research on the phenomena of lighting.

Research in the past has, in nearly every case, been hampered and narrowed in its usefulness by the restricted point of view of the individual or body of individuals conducting the work. Although this fact has long been recognized in theory, it is only comparatively recently that any serious attempt has been made to translate this recognition into practice, and in the writer's opinion the Department of Scientific and Industrial Research has marked an important date in the history of illuminating engineering by the appointment of a Research Committee on this subject, with strong representation on the ophthalmic as well as on the engineering and architectural sides.* It is the object of this paper to describe briefly what this Committee is setting out to do and how its work will assist the practising illuminating engineer and how he, in his turn, can react to assist the Committee in its work.

(2) *The Necessity for Fundamental Research as well as Investigation of Immediate Practical Problems.*—Anyone who gives any study to the subject of research in illumination is at once struck by the fact that there are a large number of fundamental problems requiring solution, or at any rate partial solution, before much

* *The Illuminating Engineer*, June, 1926, p. 163.

*The constitution of the Committee is as follows:—Mr. C. C. Paterson, O.B.E., M.Inst.C.E., M.I.E.E. (Research Laboratories of the General Electric Co. Ltd.), *Chairman*; Sir J. Herbert Parsons, D.Sc., F.R.C.S., F.R.S.; Mr. D. R. Wilson and Dr. H. Hartridge (Medical Research Council); Mr. J. W. T. Walsh, M.A., M.Sc., F.Inst.P., A.M.I.E.E. (The National Physical Laboratory); Mr. J. A. MacIntyre, O.B.E., B.Sc., M.Inst.C.E. (H.M. Office of Works); Mr. S. B. Russell and Mr. Alban Scott (Architects appointed in consultation with the Building Research Board); Mr. L. Gaster (Illuminating Engineering Society); Mr. L. B. W. Jolley (Electrical Industry) and Dr. J. S. G. Thomas (Gas Industry).

real progress can be made. These fundamental researches must, by reason of their very nature, take a long time to carry out. At the same time there are many practical problems which, for one reason or another, urgently demand a partial solution at the earliest possible moment.

An excellent example of this situation is afforded in connection with the proper lighting of streets. It will probably be conceded at once that a good system of street lighting must, in addition to giving adequate illumination, be reasonably free from glare. In fact, a system which is badly glaring may be inferior to another in which the average illumination provided is much lower but in which the sources are so designed that the glare to the road user is less. Clearly the three factors of light intensity, light distribution, and glare must all receive consideration and, as is usual in engineering problems, a compromise must be effected between them. If this compromise is to have a sounder basis than, at the best, the result of previous practical experience, or at the worst sheer guesswork, our knowledge of the phenomena involved must be very much increased. It is obvious, *a priori*, that glare increases with the intensity of the glaring source, its proximity to the eye, and its proximity to the object looked at. The brightness of the field of view generally and of the object to be discerned are also factors in the problem, and all these enter into the design of a good street-lighting system. Yet our knowledge, at the present time, of the quantitative relation existing between these many different variables is extremely limited. We are scarcely in a position, for example, to say whether the glare is improved or made worse by halving the intensity of a source and at the same time halving its distance from the object looked at. There is clearly an immense field here for systematic and painstaking research of a fundamental character, and this is but one example of what is required.

It will be obvious that a research of this kind must be exceedingly lengthy if the ground is to be thoroughly covered and if the results obtained are to be reliable. For the eye is not an instrument which can be turned out strictly to specification, and in all work on its behaviour it is clearly desirable to obtain data based on the average performance of a number of individuals. At the same time, as was stated in a paper read before this Society only a few months ago, there is a Committee of the British Engineering Standards Association which is endeavouring to draw up a Specification for Street Lighting. Such a specification is urgently needed, and it cannot wait for the results of the fundamental research on glare as outlined above.

The problem of street lighting, therefore, must be dealt with, as far as is possible in the present state of our knowledge, by means of a special *ad hoc* investigation, the results of which will, probably, be subject to some modification when the more fundamental work has been completed.

This single example will serve to show the difficulty of the situation and the position in which the Illumination Research Committee is placed. Its primary function is undoubtedly to initiate and conduct researches of a fundamental character. At the same time it has to give as much help as possible in the practical problems of the moment. It is not always easy to maintain a true balance between these two sides of the Committee's work, but it is most important always to remember that both exist and are likely to continue to do so as long as illuminating engineering is a living and progressive subject.

It will be convenient in what follows to use this dual nature of the Committee's work as a means of classification, and the following two sections will, therefore, be devoted to a description of (a) fundamental research, and (b) problems of immediate practical importance.

3. *The Work of the Illumination Research Committee: (a) Fundamental Problems.*—There are at present three fundamental researches which are proceeding under the supervision of the Committee. The first is a thorough investigation of the problems of glare, and here, perhaps, it will be as well to explain the relations which exist between the Committee and other bodies working on kindred matters. The Medical Research Council has recently appointed a Committee on the Physiology of Vision to supervise research on subjects connected with sight-testing and other problems of vision which may be referred to the Medical Research Council by the Fighting Services or other Government Departments. Naturally it is of the utmost importance that the Illumination Research Committee of the Department of Scientific and Industrial Research should be in close touch with this Committee of the Medical Research Council, and actually the Chairman and Secretary of that Committee are members of the Department of Scientific and Industrial Research Committee, while, in addition, there is a representative of the National Physical Laboratory on the Medical Research Council Committee. The liaison is thus exceedingly close, and it has been found best that the research on glare, in its fundamental aspects, should be managed by the Medical Research Council Committee, although the Department of Scientific and Industrial Research Committee is kept in close touch with its progress through the members of both Committees. At the same time, certain practically important aspects of the matter which can be dealt with directly, and for which a solution is speedily required on account of the urgency of the street-lighting problem, are being investigated by the Department of Scientific and Industrial Research Committee, and the work is being carried out on its behalf at the National Physical Laboratory.

A second fundamental problem is that of the relation between the degree of illumination and the ease and accuracy of performing fine work. This is a subject which has received partial investigation on several occasions, notably in America, but too often it has been difficult to interpret the results obtained, either because the data given were not sufficiently complete, or, more often, because the issue was complicated by making a change in the system of lighting simultaneously with the change in the illumination. The matter has received careful attention in this country, notably from the Home Office Departmental Committee on Lighting in Factories and Workshops, and it was as a result of a suggestion from the Home Office that the Illumination Research Committee decided to institute a thorough investigation of the problem. Here again the Committee has had the benefit of co-operation with a body which is expert in the type of investigation involved. The Industrial Fatigue Research Board of the Medical Research Council has conducted a large number of investigations on the effect of various factors on fatigue, and it is most fortunate that the Secretary of that Board is a member of the Illumination Research Committee. The first stage of the research, therefore, has been conducted jointly by an investigator of the Industrial Fatigue Research Board and by the staff of the National Physical Laboratory. Printing was chosen as a convenient process for the purposes of the investigation, and the Committee was most fortunate in securing the very active co-operation of the Joint Industrial Council of the Printing Trade. A stage of the work has now been completed. It shows the effect of the degree of illumination on the speed and accuracy of work, the lighting being on the direct system. The general conclusion is that increased illumination is beneficial up to about 20 foot-candles, but the results are so interesting that the complete account of the work, which will be available shortly,* will well repay detailed study by anyone interested in the subject. The effect of the system of lighting is now being investigated, and the investigation may be extended to other processes.

A third fundamental investigation now being carried out for the Committee at the National Physical Laboratory may be described briefly as the effect of fenestration on the natural lighting of rooms. This subject has long been neglected by most illuminating engineers, and it is only recently that any interest has been shown in it by anyone except the architect. It must, surely, be conceded that window design should be guided at least as much by the principles of illuminating engineering as by considerations of architectural design. Co-operation,

* "A Study of the Relation between Illumination and Efficiency in Fine Work," by H. C. Weston.

again, is needed, and again the Department of Scientific and Industrial Research has recognized this by appointing two architects as members of the Illumination Research Committee. Under their guidance the Committee has put in hand an extended series of investigations of the effect of the size and height of windows, and of interior decoration, on the lighting of rooms of various floor sizes and shapes and of different ceiling heights. Here, too, the number of variables is large, and the variety almost infinite. Further, the factors of aspect and of average sky brightness throughout the year have to be taken into account. For these reasons daily measurements of the illumination due to a quadrant of sky facing any one of the cardinal points of the compass is made at Teddington three times daily, viz., at 9 a.m., 12 noon, and 3 p.m., G.M.T. The results of these measurements, given as monthly averages, will be found in the last two annual reports of the National Physical Laboratory, and it is hoped to continue them so as to obtain averages extending over at least five years. It has been suggested that similar records in other parts of the country, and particularly in our big cities, would be of considerable value. So far, however, it has not been found possible to arrange for such measurements to be made.

The transmission of various types of window-glass has been measured both for direct light, normal to the surface of the glass, for diffused light, and for what has been called "restricted diffused light." In the first case the light passes through the glass in the form of a beam which is approximately perpendicular to the glass surface; in the second case the light is incident in all directions, as in the case of a flat roof light under an open sky; in the third case the light is restricted to angles of incidence greater than 45°. This is a very important case, as it corresponds with the condition at a vertical window opposite a building or other obstruction, the angle of elevation of which from the window is 45°. Nine different kinds of glass, including different varieties of prismatic glass, have been measured under these conditions, and the results, together with an account of the methods of measurement, are available as a technical paper of the Committee.*

It may not be altogether out of place to mention here that an accurate measurement of the daylight illumination in a room is not at all easy to obtain under ideal conditions. If a large-scale model be used—and there is provision at Teddington for working in model rooms half to two-thirds full scale—the lack of uniformity and of constancy in the brightness of the natural sky is a great difficulty. If small-scale models, say one-twelfth full scale, be used, so that an artificial sky can be substituted for the real one, other difficulties are encountered. The provision of a sufficiently uniform artificial sky is in itself no easy task, while the accurate measurement of the illumination at different points in a model room of these dimensions demands considerable ingenuity, and even then is liable to uncertainty owing to the lack of a perfectly diffusing surface. The study of so-called diffusing surfaces has, therefore, necessarily formed a part of the investigation, and work on this subject is still proceeding. This is a problem which is also of importance in the design and use of most portable illumination photometers, and it may be mentioned in passing that some of the results obtained in the course of the work for the Illumination Research Committee were used by the B.E.S.A. Committee in drawing up the recently issued Standard Specification for Portable Photometers (No. 230—1925).

(4) *The Work of the Illumination Research Committee: (b) Special Problems of Urgency.*—In addition to the three fundamental researches described in the last section, the Committee has worked on a number of other problems of smaller magnitude which, although restricted in scope, required more or less immediate attention, and as several of these concern matters of considerable importance to illuminating engineers, a brief description of them will be given here:—

(i) *Industrial Enamelled-iron Reflectors.*—There is a special form of enamelled-iron reflector which is very widely used for direct lighting in industrial and other premises. The efficiency of this reflector, i.e., the luminous output of the unit expressed as a percentage of that of the bare lamp, depends on the position of the filament with respect to the edge of the reflector. This position naturally defines the "glare angle," i.e., the least angle above the horizontal at which the filament is visible, so that a compromise must be achieved between freedom from glare and efficiency. The B.E.S.A. Committee specifying this reflector found it necessary to have precise data on the relation between these two opposing factors, and asked the Illumination Research Committee to obtain the information. The measurements were made at the National Physical Laboratory, and full details, together with the results in the form of polar curves, are available in a technical paper of the Committee.†

(ii) *The Design of Picture Galleries to give Adequate Illumination with a Minimum of Reflection.*—When the pictures in a gallery are glazed, as is generally the case in London and other large cities, the ordinary form of lantern or sloping-roof light gives rise to objectionable reflections from the dresses of spectators and from other light objects in the body of the room. The only way in which this can be avoided is to restrict as much as possible the illumination over the central floor area, and to concentrate it on the walls where the pictures are hung. This problem was referred to the Illumination Research Committee by H.M. Office of Works, and a not inconsiderable amount of work was done on a model of a proposed design. Nothing has yet been published, but it is understood that a small gallery constructed on the lines suggested will form part of the new wing at the National Gallery of British Art (Tate Gallery).

(iii) *The Effect of Colour and Distribution on the Degree of Illumination required for Comfortable Work.*—It has sometimes been found that clerical work can be carried on satisfactorily in daylight with an illumination which is noticeably less than that generally regarded as the minimum required in the case of artificial lighting. To investigate this apparent anomaly a room has been fitted up at the National Physical Laboratory, so that the same illumination can be provided by:—

(*a*) Semi-indirect lighting with vacuum lamps;
(*b*) Semi-indirect lighting with artificial daylight (blue bulb) lamps;
(*c*) Artificial window lighting with vacuum lamps;
(*d*) Artificial window lighting with artificial daylight lamps.

To obtain the artificial window lighting, the window of the room has been covered with a diffusing material, and lamps have been so arranged on the outside that the brightness of the window as seen from within is practically uniform and the distribution of light in the room corresponds to that from a window with an unobstructed view of a uniform sky. The relative merits of these different systems for the carrying on of ordinary clerical work will be investigated, and it is hoped to find out whether there is any reality in the effect which has been noticed.

(iv) *The Effect of a Flickering Illumination on Ease of Working.*—In some districts supplied with current of low periodicity, and in the case of supplies from a local machine, a flicker is sometimes noticeable, especially with high-voltage and low-wattage lamps. Although this flicker is often referred to as objectionable, there is apparently no definite information as to whether it interferes with ease of vision. The Committee has initiated an investigation of the subject, and the work is now proceeding in the Physiological Laboratory at Cambridge under the direction of one of the members of the Committee.

(v) *The Brightness of Illumination Fittings of Diffusing Glassware.*—There has for some time past been a demand for a Standard Specification for Diffusing Glassware Lighting Fittings, and as stated at a recent meeting of this Society such a specification is now being prepared by a Committee of the B.E.S.A. During

* "The Transmission Factor of Commercial Window Glasses," by A. K. Taylor and C. J. W. Grieveson.

† "The Light Distribution from Industrial Reflector Fitting No. 1 (B.S.S., No. 232—1926)," by H. Buckley and C. J. W. Grieveson.

the course of its work this Committee found it necessary to have precise information concerning the brightness of opal glass and other bowl fittings. As a result of its request, the Illumination Research Committee had an extensive series of measurements carried out at the National Physical Laboratory, and the results will shortly be available in the form of a technical paper of the Committee.

(vi) *The Temperature of Illumination Fittings under Normal Conditions of Operation.*—Another problem raised by the same Committee of the B.E.S.A. is that of measuring the temperature reached by different parts of the glassware and elsewhere in an illumination fitting. The carrying out of this work has been approved by the Committee, but no results are yet available.

(5) *Other Reports of the Committee.*—It may be mentioned that, in addition to the technical papers already referred to, there are two others which have been drawn up. One of these is a concise explanation of the technical terms used in illumination.* This report is in two parts, the first containing what may be called the engineering and photometric terms, the second containing the physiological terms. This is probably the first time in which both sides of the subject have been brought together in such an obvious way, and the issue of the report will be a direct challenge to the illuminating engineer who is content to pass over the physiological side of the subject as of no interest to him. It will equally be a call to the physiologist who studies illumination to adopt the system of units and the nomenclature already developed by the physicist and the engineer.

The other report deals with the method of measurement of mean spherical candle-power by means of the spherical or cubical integrator. This type of measurement has now become so widespread that it was thought that a monograph of this kind, containing only simple and straightforward directions for making the measurements, and with scarcely any theoretical treatment of the subject, would be of assistance to those who are interested in the everyday measurement of lamps in large quantities.

(6) *Conclusions.*—The above brief sketch of the work of the Illumination Research Committee may, perhaps, serve to show its varied character and the number of different problems upon which it is already engaged. It cannot be emphasized too strongly that the more important part of the work is the fundamental research described in section (3). Progress in such work is, however, necessarily slow, and it will, therefore, be understood that the early publications of the Committee must be the result of more restricted investigations, such as those described in section (4). This unavoidable one-sidedness in the early reports may convey a totally erroneous impression of the work which the Committee is doing unless care is taken to remove this impression by explaining the true facts of the case.

If this paper serves to make these facts more widely known among illuminating engineers, and if it succeeds in interesting them in the Committee's work it will have served the purposes for which it was written. It is beyond doubt that the work of the Committee will greatly advance our knowledge of illumination. The practising illuminating engineer can assist the Committee both by keeping himself informed of the results which it obtains, and by suggesting problems which his practical experience leads him to think are fruitful subjects for scientific investigation and research. With his co-operation man's knowledge of the subject can be increased to the great advantage of all who make use of illumination, or, in other words, to the lasting benefit of all mankind.

Discussion

Mr. C. C. PATERSON (Chairman of the Illumination Research Committee) expressed his admiration of the way in which Mr. Walsh had summarized the work of the Committee. He might add, what Mr. Walsh had not mentioned, that a very great part of the work described had been done under Mr. Walsh's personal direction. Mr. Paterson also referred briefly to the conditions leading to the formation of the Illumination Research Committee, and paid a tribute to the influence exerted by the Illuminating Engineering Society and by Mr. Gaster in helping towards the initiation of this research.

He felt that some branches of applied science suffered a good deal from the effect of the sharp professional subdivisions which existed. People who combined in themselves the knowledge of two professions and succeeded in retaining the respect of the members of either of them were very rare. An endeavour had been made to overcome the difficulties caused by professional sub-divisions by securing the services on the Committee of members of different professions. In societies such as the Illuminating Engineering Society efforts were made to bring people together so that all phases of the problem might have attention directed to them. The system worked very efficiently so far as the committees and the societies interested were concerned.

The illuminating engineering movement all over the world required the services of men who were not afraid of the knowledge and the technique of another profession, men who were really specialists, as far as possible, on both sides of the question. The Chairman of the meeting was a shining example in that respect.

It was not for him to say anything in particular about the composition of the Committee, or whether it could be bettered; but he did not see how it could be bettered. The *liaison* of the Committee with all the other bodies with whom co-operation had to take place was excellent. The Committee welcomed any suggestions and criticisms and discussions of the problems it had before it. The members of it were very anxious to hear and to read about everything which could be helpful in connection with their problems. On behalf of his colleagues on the Committee he desired to tender very hearty thanks to Mr. Walsh for so ably putting the matter before the Society.

Mr. W. J. JONES desired to join with Mr. Paterson in congratulating Mr. Walsh on his paper. He also congratulated the Society on having such a very important paper brought before it. The Illumination Research Committee had earned the respect of people in all sections of industry.

He felt that as far as possible the international aspect of the matter should be very strictly borne in mind. It was essential that it should be possible to compare the work done in Italy and the work done in America, for instance, on vision. At the present time it was often almost impossible to compare the work that was being done in different countries. That was a great pity. If general agreement could be reached on methods of testing this would be helpful in rendering results comparable. Close contact with researches conducted abroad was also necessary in order to prevent duplication of effort.

Mr. Walsh had made the very excellent suggestion that illuminating engineers should keep in touch with the publications of the Committee; but there were not very many people who knew where those publications were to be obtained. It would be a great advantage if the information contained in them was more readily available. Accounts of experiments published in *The Illuminating Engineer* were useful in this respect, and everything possible should be done to make the contents of those reports as widely known as possible.

He was much interested in the excellent research in connection with printing. At first he thought that perhaps that work would not yield such results as apparently it had yielded from the point of view of the speed of working and the amount of illumination. Setting up type became more or less automatic at times, so that one might expect that in some forms of difficult work, high-grade screw cutting for instance, the effect might be even more strikingly shown.

Mr. A. CUNNINGTON expressed his appreciation of Mr. Walsh's paper. He also congratulated Mr. Gaster on seeing, in this introductory report of the Illumination Research Committee, the outcome of his persevering efforts for so many years to initiate researches in illuminating engineering. He had come to the meeting almost

* "Definitions and Explanation of the Terminology used in Illumination and Vision."

directly from a discussion on a curiously baffling problem in connection with street lighting, which, it seemed to him, to be almost beyond the possibility of the ordinary practical illuminating engineer to tackle alone. At first sight the problem appeared to be a very simple one indeed. It concerned a public road crossed by a railway, which happened to be a very wide railway at the point in question. There were eight tracks. The railway crossed the road diagonally. The result was that there was practically a tunnel under the railway. Not very long ago, unfortunately, a fatal accident took place somewhere about the middle of the tunnel formed by the railway bridge. As a result of various suggestions which were offered, it was concluded that all that was necessary was to put a little more candle-power in the middle of the bridge and keep rather more lamps burning all day. Owing to the length of the part of the road that was covered, it was necessary for certain lamps to be burning all day in the darkest part of the bridge. Now that the recommendations of the various authorities concerned had been carried out, matters were not the least bit better than they were before. The problem was turning out to be not really one of illumination, but of avoidance of conditions giving rise to dazzle. There was "glare" from the daylight at the further end of the bridge whichever way one entered, and merely increasing the illumination did not seem to have made any difference at all. The problem clearly involved physiological considerations and seemed typical of those which might well be brought before the notice of the Illumination Research Committee.

Mr. P. J. WALDRAM suggested that the Royal Institute of British Architects, a powerful body with some thousands of members, should be represented on the Committee, especially in view of the researches it was conducting on daylight illumination. It was desirable to supplement the measurements made at Teddington by data obtained in various parts of the country. Architects were well aware that daylight conditions in a rural or semi-rural place, such as Teddington, had little relation to the terribly difficult problems that one met in the smoky areas of London, Manchester, Liverpool, and other large cities.

In connection with the design of picture galleries, it was necessary to bear in mind that reflections were of two kinds. There was, firstly, the reflection in the glass of the picture of bright objects in the room—such as the bald head or spectacles of a spectator. But there was also another form of reflection that was far more destructive to the beauty of the picture, namely, the reflection of a badly placed skylight. The restriction of illumination over the central floor area and the concentration of light on the walls where pictures were hung might be of service for the solution of the first problem. But the other and more troublesome form of reflection from badly placed skylights also required consideration.

With regard to the problem mentioned by Mr. Cunnington, would it not be possible to make perforations, filled by glazed glass if necessary, in the roof of the bridge? If that was done it would be possible to introduce some degree of illumination into the very dark regions under the bridge, thus diminishing the contrast with the bright illumination at the two ends. It was essential that the perforations should be kept absolutely water-tight; otherwise the unfortunate railway company would be inundated with claims for damage to merchandise.

Mr. W. C. RAFFÉ said that he studied illumination from the artistic side. If he were to make a list of fundamental problems for anyone to study it would be a very long one. He wanted to know many things for which it was not possible to find answers; for instance, "What is light?" "What produces colour in light?" "How does the eye see light?" "Why is the mind affected through the eye?" "Is the mind affected when light falls on the skin and not on the eye?" "What is the exact nature of light on certain metals?" It might be possible to obtain some quite interesting information as to the effect of light upon metals.

He wished to make one suggestion for the enlargement of the membership of the Committee. Not only had it no representative of the R.I.B.A., with its eight thousand members, but it had no representative of the decorating profession. He thought that it would be a good plan for the Committee to get into touch with the Institute of Decorators, and to make some study of the effects of daylight, artificial daylight, and coloured light on the problems of interior decoration.

Miss A. R. WIGGINS said that Mr. Good, of the British Engineering Standards Association, was very sorry that he was not able to be present at the meeting. He had asked her to say a word or two of appreciation of the work which the Research Committee had done. He considered that the Society was to be congratulated on arranging for the reading of papers which gave such valuable information as to the development of the work that was going on in regard to illumination.

As the Acting Secretary of the Illumination Committee of the B.E.S.A., she could to a certain extent verify what was said in the paper to the effect that the Department of Scientific and Industrial Research was carrying out its work very successfully on the widest possible basis. The Illumination Committee of the B.E.S.A. would have been greatly limited in its work but for the fact that it had had the Research Committee to which to refer its points of difficulty. The way in which the Department had always answered every appeal for assistance had been very helpful indeed. It had been commented on most favourably by many of the members of the Illumination Committee of the B.E.S.A., to whom its work had been of the greatest possible value.

Mr. J. S. DOW complimented Mr. Walsh, not only on the contents of his paper, but on the very lucid way in which the whole problem had been presented. He had shown very clearly that these fundamental problems, underlying the whole practice of illuminating engineering, could only be adequately dealt with by uniting the efforts of all the experts interested, and especially those conversant with physiological aspects. The research which had attracted most attention was naturally that dealing with the relation between illumination and accuracy and speed of work. There had been several useful recent experiments in this field of late, notably that conducted by the United States Public Health Service into the lighting of post offices and some laboratory experiments on various processes recently undertaken in Germany. These had been summarized in *The Illuminating Engineer*. Both had served to show the important influence of the nature of the process on results. It was obvious that researches conducted on a point of such fundamental importance should bear the hall-mark of authority. He believed that, from this standpoint, as well as in regard to the very careful way in which allowance had been made for all possible disturbing factors, this would be considered one of the most complete and accurate surveys yet made.

There were many other problems that one might suggest for inquiry. One of these, which might well form the subject of a preliminary discussion before the Society, was the comparison between standards for natural and artificial light. People sometimes spoke loosely about adopting, as our standard for artificial lighting, the conditions of daylight necessary for the maximum efficiency of the eye. Comparisons between natural and artificial intensities were very complex. Few people would be prepared to assert definitely whether a higher or a lower actual illumination was necessary for artificial light as compared with daylight. In all such comparisons, the effect of contrast, the influence of the presence of an overhead expanse of sky or a bright window, and the direction and diffusion of light had to be considered. Mr. Dow mentioned experiences that suggested that at a moment in fading daylight when the exterior illumination was actually still far greater than that provided by artificial light indoors the effect was that of coming from the gloom outside into a much brighter interior. Generally speaking, one's impressions of what constituted adequate natural illumination were profoundly affected by the bright expanse of sky overhead.

Mr. Dow also suggested, as another subject for physiological inquiry, the effect on the eye of different qualities of light. One occasionally met alarmist statements to the effect that the increasing use of artificial

light was responsible for progressive deterioration in vision. Whilst there was no adequate evidence available to support this view, he thought that the effect of such differences as existed in the spectra of artificial light and daylight deserved study. His attention had been drawn to the matter by his experience of recently introduced "Restlight" lighting units, which furnished a quality of lighting broadly similar to daylight. He was inclined to think that the fatigue of night work with this form of light was less than with uncorrected artificial light. Possibly the effort of accommodation was less, and, as Dr. Kerr had suggested at the last meeting, the matter might prove of special consequence for the treatment of eyes already disposed to become short-sighted.

Mr. R. C. HAWKINS added his congratulations to the author upon his very excellent paper. He was particularly interested in two problems which had been mentioned; first of all, the relation of output to artificial illumination, and, secondly, the question of artificial daylight. He quite realized the practical difficulties which had to be encountered in making tests in regard to the effect on production of illumination, because there were so many factors which cropped up, and which it was very difficult indeed to eliminate. The author had mentioned the room in the National Physical Laboratory in which clerical output under artificial daylight was being tested. He was wondering whether any figures were available as to the results in other types of work, manual work of some sort. He did not mean any type of work where the question of colour came in, but any ordinary process which did not require colour discrimination. He would also like to know whether Mr. Walsh had any experience of the use of artificial daylight in surgery or dentistry.

Mr. WILSON said that there were one or two points that he would like to raise in connection with some of the tests that had been made. The methods of making those tests were of value quite apart from the purposes for which the tests had been made. In regard to dispersive reflectors, measurements had been made with lamps at different positions from the reflector. They showed the necessity of tightening up the tolerances of the lamps. Some work had also been done on the shape of lamp filaments. That matter was one which, he thought, had to be considered by both the lamp maker and the designer of reflectors. In connection with the work on diffusing glassware the question of absorption had been raised. In many cases the figures obtained from samples given did not mean very much. If a given sample of diffusing glass was taken, and if it was made into fittings of various shapes, the absorption of the fittings would be found to vary with the varying shapes of the fittings, and with the varying positions of the lamps. If samples of a diffusing bowl were taken, they would be found to vary much owing to the different thickness of the glassware in different places. The measurement of absorption factors of glassware was a very difficult problem, for that reason. He thought that valuable work might be done on that point.

Mr. T. J. SACK referred to public lighting as a question of great national importance. It was rather an interesting problem whether the illumination of our roads by individual generating stations rushing about at 30 miles an hour was an economical method, or whether the money would not be better expended if the motorists contributed to a common fund for increasing the illumination of the streets. If one came to consider that there were one and a half million registered cars on the road, and if one added up the candle-power which they represented, he would find that the resulting figure was a very considerable one, and that it would adequately illuminate all the roads in this country. The problem "What is a good driving light?" was a very important one. Each person had a different idea on the subject. There was no scientific definition of a good driving light. The problem recently cropped up in connection with the consideration of different lamp filaments. It was not possible to start on the problem, because there was no definition of good driving light. In the consideration of such problems the Research Committee would be very helpful.

Mr. L. GASTER expressed his appreciation of the paper read by Mr. Walsh, who, in dealing with fundamental research, had happily expressed the aims of the Society, which had always recognized that many problems could only be effectively solved by the co-operation of all the various experts concerned.

One of the chief objects of the meeting was to make the work of the Committee as widely known as possible. As Mr. Walsh had explained, each of the investigations now mentioned would be dealt with in technical reports, and many of these would alone furnish scope for an evening's discussion before the Society. The research on the relation of illumination and speed and accuracy of work was of great practical importance, and might furnish some indication of the intensity of illumination that might reasonably be expected in practice. He urged that caution should be exercised in attempting to derive standards of illumination from observations of daylight. As Mr. Dow had remarked, the comparisons of artificial and natural lighting conditions was a complex problem. Because some hundreds of foot-candles might be available by natural light under favourable conditions, it did not follow that this should be the standard for artificial light. He was glad to see present Mr. Waldram, who had made a special study of daylight illumination. The various papers read by him before the Society had been largely instrumental in drawing attention to the importance of this subject, which was not generally realized before the Society had provided opportunities for discussions on this point.

Mr. Gaster remarked that in many problems physiological and ophthalmological considerations played a leading part. Therefore it had been a great asset to have the aid of the Chairman, Sir John Parsons, and the other representatives of the Medical Research Council. It was interesting to recall that the very first paper ever read before the Society was one by Sir John Parsons, analysing the nature of "glare." The paper had aroused much interest, and many definitions of glare and suggestions for its limitation were received from corresponding members of the Society all over the world. To-day this problem is still being considered, and Sir John was presiding over the Committee appointed to deal with this matter. The amount of information available to-day was very much greater than in the past, and the recognition of the disadvantages of glare much more widespread. Useful empirical rules for its avoidance had been framed, but the underlying scientific principles still required study.

The present meeting had proved a useful supplement to the recent discussion of the various B.E.S.A. reports on illumination. Both had served to show the important part played by the Society as a clearing-house for information. There were many researches which were best done by specially constituted committees, such as those working under the B.E.S.A. and the Department for Scientific and Industrial Research. The Society could aid by the initiation of such researches, in which a considerable number of its members were participating, and it fulfilled a most important function in acting as a clearing-house for the information thus acquired. It was most important that the results of researches when embodied in reports should not be overlooked, but should be discussed before the Society, and subsequently widely commented upon in the daily and technical press. He hoped that this meeting would help in drawing general attention to the valuable work being done by the Illumination Research Committee.

The CHAIRMAN (Sir John Herbert Parsons) congratulated Mr. Walsh on the very clear way in which he had described the work of the Committee. The aim of the various Committees working on the subject was to get a definite attempt at co-operation between the different aspects of the subjects and to clarify the situation. Many years ago all physicists practically ignored the biological aspects of their subject altogether. They lost sight of the fact that ultimately the criterion of all their measurements was biological. The physicists were extraordinarily lucky in their early days in hitting upon the most finely discriminative sensation possible and applying it to their instruments. It was a pure accident, as far as one could see. Every advance had

shown that the highest discriminative capacity possessed by any animal was that of contra-discrimination—the difference in the break of a line. Having got that, and applied it to their instruments, they went on gaily making all sorts of wonderful discoveries with extreme accuracy. Meanwhile the poor biologists were going on making their lumbering discoveries with extreme inaccuracy. The physiologists certainly had forgotten a great deal of what they owed to the physicists. That was brought home to him most strikingly in the extraordinary physiological interest of the work done by illuminating engineers and physicists in purely biological problems. A great deal of the most valuable physiological work with regard to vision had been done by physicists.

Ophthalmologists, as a rule, were not particularly interested in illumination. His experience was that it was extremely difficult to get ophthalmologists interested in subjects of a broader scientific and practical interest outside the medicine and surgery which were their prime preoccupation in life. That was natural; but it was rather lamentable. There were few psychologists in England who had done any work on the problems dealing with special senses and visual problems and other problems of that type. They took comparatively little interest in them, although the subject was the one subject which they ought to make the foundation of the whole of their science. The very basis of psychology was perception. The difficulty of the Committees of which he was chairman, the one on printing, typography, the legibility of type, and so on, and the other one on the physiology of vision, had not been the obtaining of money, but the getting of men who were qualified to do the work. The Illumination Committee was " up against " a good many physiological problems, and therefore it acted as a tremendous stimulus to the physiological departments and the psychological departments in the Universities.

Mr. H. S. ALLPRESS (*communicated*): Those responsible for the promotion of the meeting of the Illuminating Engineering Society to hear Mr. Walsh's lucid explanation of the constitution and aims of the Illumination Research Committee are to be congratulated on their foresight in providing early publicity for the good work of this Committee. It is to be hoped that the publicity which will be given to all their research findings will be extensive. This must result in a great impetus to the growth on a true scientific basis of the science of illuminating engineering which at present is probably more dependent on biological criteria than any other branch of engineering.

The Holophane Company, with which I am associated, was the first commercial organization to undertake research and foster public education in this direction, and I can therefore appreciate the great importance to the profession of the work of the Illumination Research Committee. They can undertake the essential fundamental research which is so badly needed, and, owing to their independent constitution, their findings will naturally meet with more ready acceptance than would be the case with a less independent organization. The essential requirements for the solution of any particular problem having been decided upon, it then remains for the manufacturer to design and experiment with apparatus which will meet these requirements, if found generally acceptable. In this way much redundant research work will be obviated, and the public will gain by having apparatus available which can be relied upon to provide the very best lighting service possible under the definite physical limitations which apparently exist in artificial illumination.

As an example, take the case of motor-car anti-dazzle devices in this country. How often is a manufacturer, with a reputation for solving difficult problems, asked: " Have you solved the problem of glare from motor headlamps . . ? " Well, the answer is that the manufacturer has never been *set* the problem in this country. What is required is that an independent scientific body should decide what constitutes the maximum safe depression of visual acuity due to glare, and determine the desirable angular limits of high candle-power in the beams, etc. The problem would then be clearly set for the manufacturer, and research by him would be encouraged until he had designed apparatus to meet with these requirements.

At present manufacturers have both to determine the essential requirements for the solution of such problems and *then* design apparatus to meet them, and there is no definite independent standard by which to judge their success.

While manufacturers may still find it necessary to maintain their own independent research, there is little doubt that *they* will welcome the outcome of any such body as the Illumination Research Committee so long as it is independent of outside influence.

LIEUT.-COL. SYLVESTER EVANS (*communicated*): I only hope that wider actual utilization of the useful results of the Illumination Research Committee of the Department of Scientific and Industrial Research will be made than the present application of certain established principles in illuminating engineering indicates. In a similar manner to that in which the Factory Act applies for manual workers, so should the office workers be guarded (against themselves largely) in the matter of illumination; it should not be a case merely for employees in occupations where experience has made the consideration of adequate and efficient illumination a necessity. The final judge may be the human eye, but does it not frequently occur that the human eye is only made to realize that it is the judge when physiological troubles arise, and the experience is bought bitterly and late? The psychological effect of illumination is a factor not to be neglected; we most of us know the depressing effect of an otherwise perfectly sound scheme of illumination. Street lighting, as the authority rightly states, cannot await the results of fundamental research on glare; but if a B.E.S.A. specification for street lighting is drawn up, how far will it be universally adhered to, allowing for financial considerations and replacement of existing lighting lay-out? The street-lighting problem presents interesting features, one of which always strikes me, as a motorist, and that is that the illumination which is good and adequate for the pedestrian is not infrequently quite inadequate and ill-disposed for traffic moving at 20 miles per hour. It is quite interesting to observe, when driving about London at night, how corners, bends, and gradients which by day are quite safe become real danger zones by dark (by artificial illumination); many an instance is known to the writer of places which would be much safer to motor traffic if entirely unlighted at night than lighted as at present. No doubt the foregoing points will receive the full attention of the representative Committee dealing with the problem.

Mr. J. W. T. WALSH, in replying to the discussion, said he wished, first of all, to express his thanks for the appreciation which had been shown by those who had spoken. That appreciation was really due to the Committee and not to him. Although he took the sole responsibility for anything stated in the paper, he had really acted merely as the mouthpiece of the Committee on this occasion.

Mr. Jones had referred to the very important matter of international agreement. He would, therefore, be interested to know that the Illumination Research Committee was in close touch with a somewhat similar body which had been set up in America under the National Research Council.

With regard to the publications of the Committee, these would be published by the Stationery Office as " Technical Papers Nos. 1, 2, 3, etc., of the Illumination Research Committee, D.S.I.R.," and they would be obtainable in the same way as other publications issued by the Stationery Office.

Several times during the course of the discussion, mention had been made of the extension of the investigation of the effect of illumination on fine work. At the moment the process of hand composing in printing was alone being investigated, but he hoped that it would be found possible to extend the investigation to other processes.

With regard to the co-operation in illuminating engineers in the direction of suggesting researches to be undertaken by the Committee, he ought to point out

that it was essential that any problem brought before the Illumination Committee should be a problem of more or less general interest, at any rate to a large section of the community. Further, he would like to emphasize the point that the Illumination Research Committee had a tremendous amount of work in front of it, and therefore it would be additionally careful to avoid undertaking any work which was already being carried out or which could be better undertaken by any other body.

He would like to remove a misapprehension with regard to the constitution of the Illumination Research Committee. As the constitution was printed in the paper, the names of the members were followed by the names of the learned bodies from which they were chosen, and it certainly appeared that those bodies were definitely represented on the Committee. That, however, was not the case; the members did not represent any particular body, but they represented an "aspect of illumination." Thus there were members representing respectively gas and electrical engineering in general, but those members did not represent any one gas or electrical organization. Similarly, although the Royal Institute of British Architects was not specifically represented, architecture was. There were so many bodies interested in illumination problems that, if the Committee had representatives of all of them upon it, it would not be a committee, but a congress.

He must plead guilty to Mr. Waldram's indictment of his remark about picture galleries. The statement in the paper was certainly incomplete, but he would like to assure Mr. Waldram that in the particular piece of work referred to the points Mr. Waldram had mentioned had been looked after very carefully by the architectural members of the Committee.

Mr. Raffé had suggested some very deep researches. It was interesting to note that one of the problems he mentioned, viz., that of the effect of light on metals, was engaging the attention of all those interested in the measurement of light. In fact, many people looked to the photo-electric cell as the photometer of the future.

He thanked Miss Wiggins for her appreciative remarks. There was a great debt due to Miss Wiggins for her work as Secretary of the Illumination Committee of the B.E.S.A.

With regard to the remarks made by Mr. Dow, he would like to take the opportunity of saying that it was, to him at any rate, extraordinarily interesting to see how nearly one could imitate, by artificial light, the actual conditions one ordinarily associated with a room lighted by daylight through a window.

He would like to thank Mr. Wilson for his remarks. It was not always possible to realize, when a particular problem was being investigated, to what extent the results obtained might assist in kindred work upon which some other investigator was engaged.

He thanked Mr. Gaster and the Chairman for their remarks. He felt that the presence of Sir Herbert Parsons on the Committee was a real guarantee that the whole thing would be properly balanced, and that nothing would go out without its being carefully scrutinized from the ophthalmological as well as from the physical side.

He wished also to thank Mr. Gaster for the opportunity he had given him of bringing the work of the Committee before the members of the Society.

A vote of thanks to the author was carried by acclamation.

On the motion of Mr. Leon Gaster, a vote of thanks was unanimously accorded to the Chairman, and the proceedings terminated.

A Critical Study of Modern Developments in the Theory and Technique of Colorimetry and Allied Sciences

A COMPREHENSIVE paper on the above title was presented by Mr. J. Guild (National Physical Laboratory) at the Optical Convention. This will no doubt appear in the Proceedings of the Convention in due course, but meantime we are giving a brief summary of its contents. The paper covered a wide ground and concluded by a useful bibliography of recent work in this field. In the introduction the important pioneering work done by Sir Wm. Abney and Professor W. Watson is recalled. Since the death of these two investigators comparatively few researches have been made in this field in this country, though there have been numerous investigations abroad. Mr. Guild has done a useful service in assembling this data.

The earlier sections of the paper review the properties of illuminants, the behaviour of the "black body" being studied in some detail. The familiar curves relating distribution of energy to temperature of incandescence are presented. Most illuminants in practical use have a distribution of energy in the spectrum closely resembling that of the black body. But the radiation of exposed surfaces is not a function of temperature only (as is the case in total enclosure) but depends on the properties of the hot substance as well. Thus the distribution may be the same but the total rate of emission per unit area of radiating surface may be less, in which case the body is termed a "gray body." Some bodies also exhibit "selective radiation," i.e., they also differ from the black body in the distribution of energy. In general no non-black radiator, whether gray or selective, can match a black body in colour and brightness simultaneously.

Researches on radiation from electric incandescent lamps are next summarized and tables are presented showing lumens per watt, colour temperature (both corrected and uncorrected). Some interest attaches to the acetylene flame which, under proper control, forms a convenient sub-standard of colour-temperature. Incandescent lamps are also serviceable, though at present gasfilled lamps are subject to various sources of uncertainty which render them unsuitable as standard of energy distribution.

The only primary and semi-primary standards of energy distribution which the colorimetrist can readily obtain are of relatively low colour-temperature, under 2500° K. But from one such standard substandards of higher colour-temperature, such as gasfilled lamps, may be calibrated. A very useful instrument for measuring colour-temperature, evolved by Priest, utilizes polarized light. A quartz plate between two nicols forms a variable filter, converting one Planckian distribution to another. Daylight itself is extremely variable in regard to colour-temperature, though artificial substitutes may be of some service in colorimetric work.

Various forms of spectrophotometers, including the N.P.L. equipment, are next described. Of recent years the substitution of the photo-electric cell for the eye has simplified procedure, though such methods must be used with discrimination. The next section of the paper deals with the photometric properties of the eye, special reference being made to the work of Ives in this field. The difficulties of heterochromatic photometry and methods of avoiding them discussed. One of the most useful is the "cascade" process, by which a given variation in colour is minimized by a series of small steps. The familiar Purkinje effect is now known to be affected not only by the intensity of the illumination but by the region of the retina on which the image of the photometric field is received. On the fovea the effect is much less pronounced than on the peripheral region. As a result of various investigations, critically examined by Gibson and Tyndall at the Bureau of Standards, the visibility function for the average eye has been deduced. This is illustrated by the curve connecting

relative visibility and wavelength, with a well defined maximum near 0·55–0·56 μ. Curves derived from tests of 125 observers (Coblentz and Emerson) are also presented.

Much interest attaches to the possibilities of physical photometry. It has often been suggested that the personal equation in heterochromatic photometry could be eliminated by the direct measurement of the energy emitted by a source, the energy at each wavelength being weighted in accordance with the relative visibility. This might be effected either by interposing a suitable template in the plane of the spectrum, the light from which is recombined to form an image on the thermopile, or by interposing a solution in the path of the rays. Solutions for this purpose have been proposed by Ives, Coblentz, Houston and others.

The final section of the paper deals with the chromatic properties of the eye, the mixing of colours, the laws of colour-matching, etc. In this connection the König-Ives colour triangle is explained and reproduced. Various systems of colour-measurement have been proposed. A comprehensive colour-album, prepared by Robert Ridgway, curator of the division of birds, United States National Museum. Munsell also evolved a system in which an attempt was made to grade samples in terms of hue saturation and luminosity. Other collections of coloured samples have been prepared by the Société Francaise des Chrysanthémistes and by Ostwald, whose Farbenatlas contained 2,500 colours. Colorimeters are chiefly either of the subtractive, monochromatic, or trichromatic types. Of the first type the Lovibond tintometer is one of the most well known. Nutting and Priest have devised monochromatic colorimeters, and various instruments enabling any hue to be imitated by the mixture of three primary colours have been worked out.

In discussing standard conditions for colorimetry the author refers to the difficult and fundamental problem of a standard white light. "North sky light," besides being far from constant is much too blue to be taken as the subjective impression of white. In the theoretical work of Ives, Priest and others it has become conventional to take the energy distribution of a black body at 5000° K. as standard white for colorimetric calculations. But in practice this cannot be realized as a laboratory source of light, all known sources giving an approximately Planckian energy distribution being of much lower colour-temperature. Priest's rotatory filter, based on the use of crossed nicols and a quartz plate, has much to recommend it; but in practice it is difficult in this way to build a filter of adequate size for illuminating specimens.

The only reasonably and cheap and reliable method consists in using a suitable tinted glass filter in front of the source. Numerous "artificial daylight" lamps based on this method have been produced. The better types are invaluable for colour-matching. But coloured glasses are not sufficiently reproduceable in colour, nor are their energy curves sufficiently close to that of the 5000° K. black body for such lamps to be used as accurate laboratory standards. Similar considerations apply to stained gelative filters. The only method of obtaining a definitely reproduceable energy distribution is by means of filters consisting of solutions of suitable substances in definite concentrations.

Research on Ultra-Violet Radiation

According to the latest Report of the Medical Research Council two sub-committees are being formed to study effects of ultra-violet light. One of these is concerned with the problem of measuring the energy of ultra-violet light of different wavelengths, the other will report on therapeutic and other biological actions of light. Further evidence of the general interest being taken in this subject is afforded by the recent formation of the "Italian Ultra-Violet Association," inaugurated in the auditorium of the Surgical Clinic attached to the Royal University of Milan. We notice that *Modern Sunlight* is advocating the establishment in London of a Light Institute, where theory and practice may be studied simultaneously.

The National Physical Laboratory

Annual Visit

The usual annual visit to the National Physical Laboratory took place on June 22nd, when visitors were received by Sir Ernest Rutherford, O.M., President of the Royal Society, Chairman of the Board, the Director, and others. The weather conditions were fortunate and there was a good attendance.

As usual the standard exhibits at the Laboratory, in the Aerodynamics, Engineering and Metallurgy Departments, the William Froude National Tank, etc., attracted many visitors: many interesting experiments, including those relating to X-ray examination of crystals, were shown in the Physics and Optics Departments. In the latter department a flicker photometer for heterochromatic photometry, and the visual spectrophotometric equipment embodying the Lummer Brodhun contrast field were shown.

In the Photometry Division (Electrotechnics Dept.), the most interesting apparatus was the large-sized Integrating Sphere, with which much useful experimental work is being done, and a supplementary cubical box integrator. There were also the familiar demonstrations of spectrophotometry and the life testing of electric lamps, and an exhibit showing the use of photo-electric cells in photometry—another line of experiment that is being pursued with promising results.

The Illumination building is now in full operation and the measurement of daylight illumination in rooms of various sizes by means of small models, the determination of the "daylight factor," etc., were explained. Another interesting research in a room in an adjacent building is that bearing on the imitation of daylight by artificial means. The room devoted to these experiments is provided with special windows filled by glass covered with translucent paper so as to produce a diffusing effect. Behind these, groups of lamps with tinted "daylight" bulbs are arranged. In this way conditions approaching quite nearly to those characteristic of natural light in regard to colour and distribution can be produced. In another room there was a demonstration of some experiments on the effect of glare in diminishing visual sensitiveness. This was studied by examining a faintly luminous spot, adjacent to which was an aperture through which bright light was transmitted. The position of this "glare spot" relative to the faintly luminous test-spot can be varied, and its influence in diminishing the sensitiveness of the eye to small changes in brightness examined.

Annual Report of the Laboratoire Central d'Électricité

The annual report of the Laboratoire Central d'Electricité, presented by M. Paul Janet in the Bulletin de la Société Française des Electriciens, shows that the Laboratory has been actively concerned with illumination. The demand for standard lamps is continually growing, and there is every evidence of the desire by lamp manufacturers to exercise careful control over manufacture. The campaign for better lighting has led to the wider use of diffusing apparatus, the study of polar curves of light distribution and the measurement of luminous flux. Tests on a 200-amp. searchlight for use at sea are also reported. Measurements have been made of illumination in various buildings and the co-operation of the Laboratory has been sought by architects. A number of miners' lamps have been submitted for test. Researches on heterochromatic photometry are being pursued by MM. Jouast and Waguet. These experiments have necessitated the construction of a flicker photometer of a type resembling that in use in the United States, and M. Fabry has given his aid in the design of the optical part of the apparatus. The Laboratory is also engaged on the realization of standards of sensitometry for photographic work.

The New Cosmic Rays

Steady progress has been made in the study of X-rays and to-day a much greater degree of penetration has been attained. At a recent Conversazione of the Royal Society a demonstration of the passage of such rays through 4½ inches of steel was given. To the metallurgist this gain in penetration is of considerable moment, as it improves the possibilities of using this method to examine flaws in masses of metal. It is, however, now believed that there are forms of rays even more penetrating. The new "Cosmic Rays" discovered by Professor Millikan in the United States are said to be capable of penetrating 6 inches of solid lead. Their origin is something of a mystery. Apparently, as their name implies, they reach this earth from "somewhere in space." Confirmation is given to this suggestion by the discovery that their power is a function of the depth of the earth's atmosphere penetrated. Dr. E. E. Fournier d'Albe in a recent article in *The Observer* tells the story of the ingenious experiment by which this was established. Millikan and Bowen, in the course of their experiments in Texas, launched four pairs of small balloons into the air. Each balloon carried a small registering thermometer, a recording barometer and a Wulf quartz fibre electroscope with photographic registering film driven by a watch movement. The balloons also carried instructions to the honest finder for their safe return. Three out of four balloons were found and returned. One of them proved to have ascended for a height of 10 miles, and was found 80 miles away from the point of departure. The tale told by the records was decisive. The penetrating power of the radiation increased steadily with the height above ground, being, at a height of 10 miles, three times as powerful as at the starting point.

Some further researches, by Millikan and Otis, have since appeared in the *Physical Review*. These experiments dealt mainly with observations on mountain peaks, but also summarized results attained by the use of instruments mounted on aeroplanes. The latter data completely confirm the belief that, after an initial stage, the penetrating radiation increases continuously with altitude. It is interesting to observe that there is no dependence of the penetration on daylight or darkness, nor upon the position of any of the heavenly bodies.

The experiments on mountain peaks are apparently concerned with a form of rays different from those recorded at very high altitudes. There is on mountain peaks a copious radiation of local origin and of a hardness not greater than that of the gamma rays of radium or thorium; but the experiments on mountain tops reveal so far no penetrating radiation of "cosmic origin." But whatever may be the origin of the new rays it is surely one of the most striking illustrations of undiscovered facts that this "natural" penetrative radiation has only been detected long after our production of the X-rays by artificial means.

Röntgen Ray Demonstrations in Lighted Rooms

We notice in *Lichttechnik* an account of a simple expedient, based on complementary colours, which is being adopted in the Friedrichshain Hospital in Berlin to enable Röntgen Ray demonstrations to be made in a lighted room. The overhead light units are of the indirect type, but instead of the usual white over-reflector a reflector covered with a special red preparation is used. The room is thus illuminated by red light. In front of the fluorescent screen a translucent green curtain is mounted, and this appears substantially black. Hence when the Röntgen Ray apparatus is put in operation the fluorescent green image can be clearly seen and is unaffected by the adjacent illumination. The device has the obvious advantage of enabling operators to see their way about the room and inspect dials of instruments, etc., and is also preferable from the standpoint of patients, many of whom, especially young children, dislike being left in complete darkness. The illumination is also sufficient for operators to be able to read and make notes whilst the work is in progress.

The Germicidal Action of Ultra-Violet Radiation

A useful survey of information on the germicidal action of ultra-violet radiation is contained in a scientific paper recently issued by the Bureau of Standards (Washington). Dr. W. W. Coblentz and Mr. H. R. Fulton, who are responsible for this investigation, point out that whilst much literature on this subject is available little information is given on the relation of energy available to abiotic action. They have, therefore, attempted to present results on a quantitative radiometric basis.

In isolating various regions of the ultra-violet spectrum suitable absorption screens were employed. Advantage was also taken of the presence of a well-defined band of absorption in mica at 2,660$\mu\mu$. Tests were made on a quartz-tube mercury-vapour lamp, the organism acted upon being the *Bacillus coli communis*.

The chief conclusions of the investigation were as follows:—

(1) Germicidal action is produced by radiation extending from the very short Schumann rays up to and including the 3,650$\mu\mu$ line—a wider range than has hitherto been assumed owing to the time of exposure not having been sufficiently prolonged.

(2) The intensity of lethal action varies inversely as the wavelength; that of wavelength less than 2,800$\mu\mu$ is at least ten times more rapid than that of wavelengths greater than 3,050$\mu\mu$—even allowing for the fact that the latter are of much lower intensity.

(3) No difference is observed in abiotic action when the total exposure is applied continuously, or intermittently with long or short intervals of rest. The killing effect is therefore cumulative, and intermittent exposure does not have a latent effect either in stimulating growth or in continuing the lethal action during the intervals of rest.

(4) On low intensities lethal action is greatly retarded. (On very low intensities there are some indications of stimulation instead of lethal action, but this is not fully confirmed.)

(5) With the source of radiation used (the quartz-tube mercury-vapour lamp) the most active germicidal rays are between 1,700 and 2,800$\mu\mu$. The energy value required to kill a bacterium is very small, being of the order 19×10^{-12} watt.

(6) In order to produce a rapid abiotic action (in one second) the radiant flux of the germicidal radiation must exceed a certain threshold value, which is of the order of 25 microwatts per square millimetre. Such may be obtained at a distance of 15 cm. from a 110-volt quartz-tube mercury arc lamp consuming 320 watts (80 volts 4 amperes).

Recommendations of the Illuminating Engineering Society in Germany

We reproduced in this journal last year the recommendations of the German Illuminating Engineering Society on the lighting of buildings, factories and open spaces.* On that occasion we mentioned that it was proposed to reissue these recommendations with popular explanations and illustrations showing the effects of good good and bad lighting. Through the courtesy of Dr. Lux, one of our correspondents in Berlin, we have now received a copy of this illustrated booklet. This contains a number of effective contrasts. Thus the difference in appearance of a room receiving local desk lighting aided by general lighting, and the same room equipped with a desk light only, is well shown. Other illustrations show how the substitution of translucent diffusing shades on local lights, instead of opaque reflectors, helps to relieve the surrounding darkness. Wrong methods of using semi-indirect lighting, for instance the amount of open bowls too near the ceiling, giving rise to a patchy effect coupled with inadequate illumination on the working area, are likewise discussed. It may be recalled that the same idea was adopted in the illustrated booklet "Light and Illumination: Their Use and Misuse," which we published in 1912.

* *The Illuminating Engineer*, Vol. XVIII, 1925; pp. 96,130.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)

Notes on Electric Lamps

No. 12

GASFILLED LAMPS

By W. J. JONES, B.Sc., A.M.I.E.E.

(E.L.M.A. Lighting Service Bureau).

IN a previous article it was shown that the presence of an inert gas in the bulb of an incandescent lamp makes it possible for the filament to be operated at an increased temperature and thus results in increased light output and efficiency when the filament is spiralized. The function of the gas is to reduce the tendency of the filament to evaporate when heated to a high temperature, but at the same time it is the cause of a considerable amount of heat being taken away from the filament by convection. The hot gas in the immediate vicinity of the filament rises, and its place is taken by cooler gas, and there is in this manner a continuous transfer of heat from the filament to the bulb.

The gasfilled lamp is designed to burn in a pendant position, so that the upward current of hot gases may deposit any particles which may tend to produce blackening in the neck of the bulb where such blackening would produce the minimum amount of screening. When, however, the gasfilled lamp is operated on its side or upside down, these conditions are disturbed and the following may result:—

1. There may be undue heating of the bulb immediately above the filament. In the case of projector lamps designed to burn pendantwise this intense heat will produce blistering of the bulb.
2. Any blackening which would ordinarily take place in the neck is now deposited on the bulb and reduces the amount of light that the lamp will emit.
3. Since the path of the convection gas is materially reduced there may be a disturbance of the temperature of the filament, which in turn may give rise to conditions adversely affecting the life of the lamp.

It was with this last in mind that the British Engineering Standards Association Specification No. 161 prescribes that the normal standard types of incandescent lamps could only be expected to have an average life of 1,000 hours providing the lamp is burnt in the designed position. Any departure from these conditions will necessarily involve some slight sacrifice which is not covered by the specification.

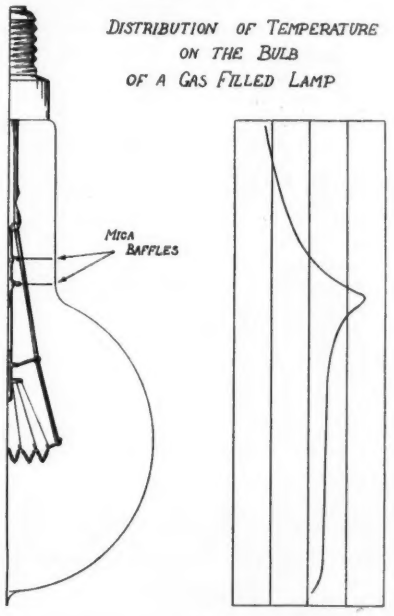
The larger the gasfilled lamp the greater the amount of energy that has to be dissipated and the more important becomes the question of pendant burning, while in the smaller sizes of gasfilled lamps the effect is of comparatively small magnitude.

Heating of Bulb.—In the vacuum lamp heat can only escape from the filament in two ways:—

1. By conduction through the leads;
2. By direct radiation;

and the bulb of the filament is not subjected to much heat. In the case, however, of the gasfilled lamp there is an additional source of lost heat, namely, that due to the transfer of heat by convection, and which explains the fact that the temperature of the bulb of the gasfilled lamp is considerably greater than that of the vacuum type lamp.

It must be obvious, from what has already been mentioned regarding the circulation of gas inside the lamp, that the hottest part of the bulb will be immediately above the filament. In most cases the point of maximum temperature coincides at the juncture of the bulb with the neck, and becomes still more noticeable in the larger lamps in which mica baffles are fitted at this point. The mica baffle is introduced in these large lamps to reduce the temperature of the upper parts of the neck, where the leads conveying the current to the filament pass through the glass seal. The illustration indicates the kind of variation of temperature which occurs in the bulb of the gasfilled lamp.



The introduction of a gasfilled lamp into a lighting fitting, therefore, requires special consideration to ensure that the heat evolved is effectively dissipated. Most of the fittings sold by manufacturers of repute are of sufficiently generous size to provide enough radiating surface for dissipating the heat without producing undue heating up of the lamp within. A warning, however, is necessary to avoid fittings and glassware of inadequate proportions. When, however, large lamps of, say, 500-watts and upwards are being considered, it becomes more difficult to provide facilities for distributing the heat, and most large fittings are for this reason ventilated.

The consensus of opinion at the present time indicates that the provision of ventilation in fittings taking the smaller or medium size lamps is unnecessary, and that ventilation may be attendant with other difficulties, such as undue heating of the cap and directly encouraging the deposition of dust. There is apparently no reason why these gasfilled lamps should not be entirely enclosed in glassware, provided the glassware is sufficiently large.

One is often asked the question whether the temperature of the bulb of the gasfilled lamp is sufficient to be in any way dangerous, and it is reassuring to know that the temperature, certainly in the smaller sizes, is insufficient to produce charring and certainly not cause ignition, under ordinary circumstances. The larger lamps, however, may cause some charring of paper or fabrics when in intimate contact with the bulb, but a relatively small clearance will render this definitely impossible.

Lighting Exhibit at Glasgow

The exhibition in connection with the I.M.E.A. meeting at Glasgow was devoted largely to meters, electric heating and cooking apparatus etc., but we are glad to note that lighting was not overlooked. An informative exhibit arranged by the E.L.M.A. Lighting Service Bureau, under the direction of Mr. H. E. Hughes, included a lamp-cabinet showing a wide range of standard lamps; this is so arranged that by pressing a key any lamp can be lighted up and at the same time the number of hours burning per kilowatt-hour is indicated on a luminous sign. White and colour-sprayed lamps in variety were also shown, and the familiar home-lighting cabinet illustrating the difference between good and bad methods of domestic lighting. Yet another another item was a series of cabinets designed to illustrate the great progress made in electric lighting during recent years. Thus the lighting of the home, a spinning loom, a factory and a colliery were in turn dealt with. In the foreground an obsolete lighting device was usually contrasted with the latest electric lighting unit; in the background photos of modern installations and sketches of antiquated arrangements could be compared. There were also model show-windows illustrating the drawbacks of glare and the advantages of lamps being concealed from view and equipped with suitable reflectors.

An Autumn Domestic Lighting Campaign

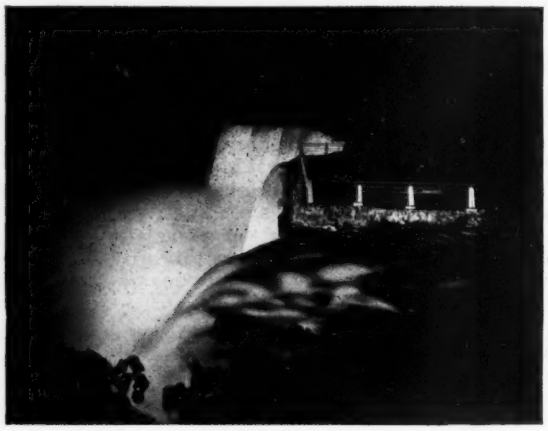
Last autumn special attention was devoted to propaganda on shop lighting. We understand that this year the autumn programme of the Electrical Development Association, Ltd., will deal mainly with domestic lighting, and will include extensive advertising and distribution of literature. An enterprising step is the organization of a ballot, the first prize for which will be an electric house, and the second electrical equipment to the value of several hundred pounds. In this campaign the E.L.M.A. is co-operating with the E.D.A., and we understand that the E.L.M.A. Lighting Service Bureau is preparing other striking demonstrations of the benefits of good lighting in the home.

Navigation Lights Supplied by Primary Batteries

In the *General Electric Review* (U.S.A.), Mr. A. W. Tupper recently gave an account of a form of navigation light, now being used on the rivers and lakes of the United States, but not very familiar in this country—the unattended flashlight deriving its current from primary batteries. The form generally used consists of a small insect-proof lantern having a Fresnel lens of about 6 in. in diameter, a 0·5 amp. 10 volt lamp and 14 to 16 Edison primary cells of 500 amp.-hr. capacity. About 30 single flashes per minute of about 1/5 sec. duration are given. The " flashing " gives a distinctive character to the light and renders the use of red glass, with its high absorption of light, unnecessary. It has also the advantage of extending the life of a battery, which in these circumstances is about 320 days. These lights can be left unattended for long periods and the consumption does not exceed 5 to 10 watts per light. This corresponds to a range of from 5 to 8 miles for cylindrical lenses (360° visibility) and 14 to 16 miles with reflectors of the headlight type. There are about 50 to 60 of these primary battery lights now in use by the U.S.A. Lighthouse Service and, whilst subject to obvious limitations, they have a distinct field of utility.

The Floodlighting of Niagara Falls

The accompanying illustration, sent us by a correspondent, gives a good idea of the effect of the illumination by night of Niagara Falls, a floodlighting installation on a large scale. The illumination is effected by batteries of searchlights mounted on towers at the rear of the Falls. The searchlights used possess some special features. The silvered glass mirrors are mounted in metal casing as a means of protection against mechanical injury, room being allowed for expansion due to the heat of the arc. The lamp is of the horizontal type and is trained by a single lever and handle. Rheostats are used to control the searchlights, which are estimated to yield a total beam-candlepower of 4,500,000.



NIAGARA FALLS.
Brink of American and Bridal Veil Falls.

The " Light-Colour Player "

In a paper recently presented before the Illuminating Engineering Society in the United States, Miss M. H. Greenewalt discusses the idea of the " light-colour player," an instrument designed to produce variations and combinations of coloured light on the screen—a process that has been described as " the art of mobile light and colour." It is now many years since the conception of a " colour organ " was originated. Whether the art of changing light and colours can become as popular and recognized as music remains to be seen. In theory it might be urged that there are as great possibilities in catering for the taste of the refined eye as for the ear; but in practice, as on the stage, the art of using coloured light has usually been accompanied by other appeals to the eye and the ear. There can be no doubt, however, of the great influence exercised by light and colour on the mind, and in places of entertainment more especially on the stage and in the kinema theatre, this is being increasingly realized. In the kinema theatre the use of " colour-lighting " is used not only to supplement the action of the film but also a subtle preparation for the display which creates the desired mental atmosphere. Miss Hallock mentions as a simple illustration the change of mood occasioned by the passage of a heavy cloud across the face of the sun, or the gradual transformation of a brilliant morning into a cloudy day. Conversely when a gloomy day clears in a radiant sunset the mind is at once encouraged and impressed with the conviction that " all's right with the world."

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Light in the Home*

By M. LUCKIESH

MAN is the product of outdoor environment. We should realize that we have not lived indoors long enough to alter fundamentally our eyes, evolved under certain outdoor distributions of light and of brightness and under certain intensities of illumination. Only in recent decades has mankind lived and worked long hours under artificial lighting. These hours are becoming longer and the importance of proper lighting is greatly increasing.

When modern artificial light-sources appeared less than a score of years ago a new science and art of lighting began. Scientific men and others have applied themselves to the task of determining good and bad lighting conditions. There is no reason why artificial lighting cannot be made to serve as a successful substitute for natural lighting under which our eyes evolved, but it cannot serve as it should in homes and in schoolrooms until knowledge of lighting is substituted for indifference to lighting.

Light is essential to vision; without light the eyes are useless, but light is only the raw material. Proper and adequate lighting is the finished product. Quantity of light has a great deal to do with visibility. The distribution of brightness in the field of view has much to do with our ability to see with comfort.

When the intensity of illumination is insufficient we hold the printed page, or whatever we desire to see, close to our eyes. Anyone may recall that as he sits on the porch reading as daylight is waning he holds the book closer and closer to his eyes. When the distance is abnormally short his eyes are strained.

There are so many factors involved that it is difficult to separate from the records the part that bad lighting plays in impairing vision. However, we know that light is essential; that it may be adequate or inadequate; that it may be proper or improper; that in any case artificial lighting has never approached the ideal in intensity.

Now let us consider some other factors. A bare light-source in the field of view shines on the eyes. Certainly the light which illuminates the eyes is not illuminating the work. It attracts the attention. It is distracting. We may not be conscious of the battle being waged by the eye-muscles to keep the eyes fixed upon their work. A constant strain is placed upon these muscles. This is fatiguing and annoying. It may cause discomfort and nervousness. In various ways the bright light-source is a counter attraction which can serve no useful purpose and certainly is harmful to vision.

There is plenty of evidence that good lighting aids vision and is an economic asset. It should be observed that in most cases good lighting costs no more than bad lighting. If we take into account the harm which bad lighting does to the eyes, it is much more costly than adequate and proper lighting. Eyesight is so important and so easily injured that too much care cannot be exercised in its conservation.

Lighting conditions which cause eyestrain depend somewhat upon the state of adaptation of the eye, so it is difficult to define in measurable quantities the limits of these conditions. Excessive brightness, like that of the sun or of modern artificial light-sources, is annoying and harmful to vision. The type of glare due to excessive brightness is blinding for some time after the light-source is out of the field of vision, and this temporary blindness has been the cause of many accidents.

Excessive contrast, which in a sense is similar to the foregoing, causes eyestrain. A brightness which is quite endurable amid light surroundings may be quite discomforting amid dark surroundings. For example, a lighted lantern outdoors on a dark night or a lighted match in a room painted black is quite glaring; while a lighted incandescent lamp when viewed against the bright sky in the daytime is not very glaring.

The light from a wall-bracket, which may be viewed with comfort against a light or medium grey wall, is likely to be glaring against a dark background such as a dark wall-paper or darkly finished woodwork. Despite this, brackets with frosted lamps are found in many homes installed on a panelled background of dark woodwork or other wall-covering. A decorative fixture which is too bright may be improved by providing denser shades or lamps of lower intensity. In general, fixtures viewed against dark backgrounds are glaring even though the brightness is very low, but this is due to the fact that the contrast is too great. But there is little in favour of dark backgrounds in the home, for they usually contribute towards a depressing effect.

Light may be glaring by virtue of its quantity, but there is a common misconception regarding this. For example, complaints are often heard that artificial lighting is too intense. The intensity of illumination outdoors is usually thousands of times greater than ordinarily encountered in artificial lighting. Commonly, when a room is considered to be over-lighted, the effect is merely glare from exposed light-sources. Quantity of light alone is not uncomfortable to vision when the eyes are adapted to the proper level of illumination. When one enters a lighted room after long exposure to darkness the eyes are blinded until they have time to become adapted. Adaptation is an important factor in vision, and by this function the eyes are capable of operating satisfactorily throughout a very extensive range of brightnesses or illumination intensities. The brightnesses encountered on a starlit night and those at noon on a sunny summer day represent a range of millions. Under proper conditions the eye will function comfortably throughout this tremendous range of illumination intensities.

Although the sky when viewed outdoors may not be annoying to the eyes, it is not uncommon indoors to find a patch of sky seen through a window to be very glaring. The eyes indoors are adapted to much lower brightnesses than outdoors, and the contrast between the patch of sky and the adjacent walls is so great as to be annoying. This is a common cause of eyestrain indoors.

Unshaded light-sources should not be tolerated. Even exposed frosted lamps are glaring under most conditions. Shades should be dense enough to reduce the brightness of the lamps. Even though the bright light-source is out of the ordinary field of view, it is annoying when reflected from glossy paper, polished desk tops, blackboards, etc. For this reason light should be emitted from a surface of low brightness. A practical solution is to surround the light-sources with diffusing glass or to diffuse the light by reflection from the ceiling.

Glossy paper is annoying because its smooth surface acts somewhat like a mirror. This is another cause of eyestrain and is contributory to such defects as nearsightedness. Where schoolchildren are required to read fine print on glossy paper under glaring or insufficient lighting, nearsightedness increases. The eyes of these young persons are immature and susceptible to permanent defects. In the home these causes of eyestrain should be eliminated before the decorative features of lighting are given attention. The eyes may be misused under any conditions if knowledge and care are not exercised, and it is deplorable that such misuse is common.

It is an interesting fact that there is more eyestrain encountered under glaring lighting conditions when the eyes are called upon for near work, such as that of reading, than when they are merely in casual use. For example, in the shade of a building with the eyes unshaded a large expanse of sky may be only slightly glaring. However, as soon as the eyes are concentrated upon a page of reading matter and are engaged in the effort of reading, one becomes conscious of discomfort which in time may become unbearable unless the eyes are shaded. A similar effect may be detected indoors; that is, glaring conditions become much more annoying when the eyes are called upon for their best efforts.

The home and the school are natural and effective places for attacking some of the evils which contribute toward eye trouble. The lighting should be well done; householders and teachers should apply the principles of conserving vision; and in the home-economic courses lighting should be given the attention it deserves.

Although it is not difficult to obtain fixtures which are thoroughly satisfactory from the standpoint of the con-

* Abstract of an address delivered before the Eyesight Conservation Council of America.

servation of vision, there are many in use which are a menace to eyesight. It is easy to state that all lamps should be shaded from the field of view and to add certain facts regarding the correct position in respect to the light-source, but these simple statements do not appear to be effective. This suggests an interesting example of a misconception of art. The bespangled fixtures of the Louis XIV period fitted appropriately the gorgeous splendour of that time. Catering to our weakness—and his own—for copying bygone art instead of creating new styles, the fixture designer reproduces those cut-glass fixtures. As objects, they may be beautiful, and as fixtures used with candles of a few centuries ago they would be delightfully scintillating. However, quite unconscious of the law of appropriateness and of the enormously greater brightnesses of modern light-sources, the architect, decorator, or someone else places our modern lamps amid crystals of glass. The glittering points of light are now a thousand times brighter than they were when this period style was born. They are glaring and unbearable. They are inartistic, despite the fidelity with which their dimensions and details have been copied. Such errors are committed in the name of art, but the result is no longer art.

The lighting problems in the home are not difficult to solve. The subject has been given a great deal of attention by experts, and simple directions for various rooms are available.

The modern living-room is a place of many recreational activities. While the average home to-day has one or two portable lamps, the living room is the place where several may be used, e.g., one on the library table, a floor lamp for the piano, a floor lamp near an easy chair, and at the davenport. In purchasing a portable lamp one should examine the lighting effect by sitting down by it and noting the spread of light and the shading of the light-sources. One of the primary faults of portable lamps is that usually not enough light escapes upward. Open-topped portables are very much to be desired. One of the great advantages of the portable lamp is that it supplies light where desired, and that it may be decorative as well as useful. The use of portable lamps does not mean that ceiling fixtures should not be installed so that they may be used when desired, or that wall-brackets should not be supplied. However, the wall-brackets in living-rooms should be considered largely from a decorative standpoint, and should contain small lamps which are well shaded.

In the dining-room the table is the important area, and it should be dominantly illuminated. This can be done very satisfactorily with the large pendant shade which is commonly called a dome or with the shower-fixture which contains several shades. Candles well shaded are useful and ornamental on the buffet and elsewhere. This lighting does not preclude the possibility of using candles on the table occasionally, but they should be well shaded.

Most kitchens to-day have a drop-cord from the ceiling or a combination fixture from the centre of the ceiling. The best lighting unit for the kitchen is one with an enclosing, diffusing glass, fastened close to the ceiling. This provides general lighting for the kitchen, but in order to avoid the necessity of working in shadows a wall-bracket equipped with a diffusing glass shade may be placed over the sink or at any other work-places where it seems necessary.

In the bedroom, general illumination is not as important as the lighting at the mirrored furniture. The best lighting is obtained by means of shaded wall-brackets on both sides of all mirrors. Portable lamps may be used for this purpose, provided they are obtained of proper height and design. Brackets may be fastened to the mirrors which makes it possible to alter the position of the various pieces of furniture, as desired. A portable lamp at the bedside is useful for reading and for emergency lighting during the night. A decorative fixture may be installed in the centre of the ceiling for general illumination on entering the room.

In the bathroom the mirror is the primary consideration, and the best lighting is to have a wall-bracket with a dense shade on both sides of the mirror at a height of about 66 inches. In small bathrooms a ceiling fixture is not necessary, although sometimes the householder desires it.

One should visualize living in the home, when considering the plans for it. This makes it possible, through the application of common sense and imagination, to locate the outlets and switches where they will be most convenient. The hallways, porches, entrances and garages should not be overlooked. In such rooms as the living room, several convenience-outlets should be available.

This is just a brief summary of lighting the home. Those interested will find plenty of material available and, in fact, if they will study the problem carefully, they will find that their own common sense can solve most of the problems. However, indifference must be replaced by interest, and everyone must realize the great importance of lighting in conserving vision and in making our homes better places in which to live.

Conditions of Health in Urban and Rural Areas

A somewhat unexpected conclusion has been reached in a statistical survey of the health of 5,031 students of the University of Minnesota (U.S.A.), which is summarized in *The Bulletin of Hygiene*. Places of residence were grouped as villages (50-1,000 population), towns (1,000-5,000), small cities (5,000-50,000), and large cities (50,000 and over). The majority of ailments and defects recorded were found to be more prevalent in villages and rural areas, and less frequent in large cities. This is opposed to preconceived ideas, as it is generally supposed that people coming from the country are of healthier stock than those who are town-bred, owing to the advantages enjoyed in regard to purer air and more sunlight. The above results, if confirmed, are a tribute to present urban health practice in hygiene.

Size 6×9 in. Pp. 186, with 64 illustrations. Price **18s.** net, postage 6d.

LIGHTING IN RELATION TO PUBLIC HEALTH

By **JANET H. CLARK, M.D.,** Associate Professor of Physiological Hygiene, School of Hygiene, Johns Hopkins University, Baltimore.

¶ This book deals exhaustively with The Importance of Light in the School, Hospital, Factory, Office and the Public Highway. There are chapters also on The Measurement of Illumination, Development of Illumination, The Best Conditions of Illumination, Indoor Illumination, as well as many others dealing with the varied phases of the subject.

MODERN SUNLIGHT says: "A masterly summary and analysis of all the available data on the subject of lighting in relation to health . . . will repay study by the technical director of industries concerned."

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LIGHT AND HEALTH

By **M. LUCKIESH,** Director Lighting Research Laboratory, General Electric Co., and **A. J. PACINI,** Director Department of Biophysical Research, General Electric Co.

¶ The object of this book is to sort out sufficient data to present, in simple language, a complete picture of the relationship of light and radiation to health.

¶ Limitation of space will not allow a full contents to be given, but some of the subjects treated are as follows:—The Nature of Light and Radiation—Climate and the Human Race—Light and Life—Light and Infection—Light and Hygiene—The Psychological Effects of Light—Lighting for Health and Happiness, etc., etc.

MODERN SUNLIGHT says: "This book contains much valuable information."

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FIG. 1.—Whitehall, London's most important thoroughfare, with its magnificent Government buildings, is one of the best lighted streets in the world. High-pressure incandescent gas lamps are used for its illumination and add to the dignity of a street famous for its fine examples of British architecture. Each lamp is fitted with two high-pressure inverted incandescent gas burners and gives a light of over 2,000 candle-power. The lamps are turned on individually by lamplighters.

The Lighting-up and Extinguishing of High-Pressure Gas Lamps

IN the December, 1925, issue of this journal particulars were given of high-pressure gas lamps for the lighting of buildings and public thoroughfares. The February, 1926, issue contained a full description of the raising and lowering gear for high-pressure gas lamps for street lighting, with special reference to lamps hung centrally over the highway. The following notes give particulars of the various methods of lighting and extinguishing high-pressure gas lamps, including distant control, or automatic lighting, the latter a necessity when raising and lowering gear is used, but equally applicable to ordinary street lighting and interior and exterior shop lighting by high-pressure gas lamps.

The methods of lighting high-pressure gas lamps may be summarized as follows :—

(1) Where no by-passes are required, the lamps are supplied with plain lever cocks, and the lighting of the individual lamps is done with the aid of a spirit torch.

(2) When by-passes are fitted to the lamps and each lamp has to be visited for lighting-up and extinguishing, a governed flashing by-pass cock is utilized, the lever being pulled into its proper position by hand. The pilot light is governed in a manner which ensures that a flame of constant size is maintained whether the gas pressure at any time is high or low. When the light is turned on, however, an elongation of the pilot flame automatically takes place to ensure the immediate lighting-up of the burner as soon as the gas is passing through it.

(3) When groups of lamps have to be lighted up from a distance, each lamp is fitted with an automatic lighter, and the line of piping supplying the group is sometimes controlled by a special valve, the turning of which lights up or extinguishes the lamps. This valve is not always necessary if the whole of the lamps taking their supplies from the high-pressure main are to be lighted simultaneously and extinguished simultaneously. In this case the starting and stopping of the compressor plant will operate the automatic lighters.

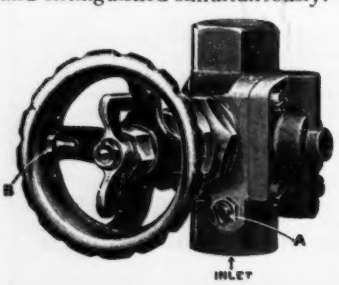


FIG. 2.—When groups of high-pressure gas lamps have to be lighted up from a distance, each lamp is fitted with an automatic lighter, and the line of piping supplying the group is generally controlled by the special valve shown in the accompanying illustration. The turning of this valve lights up or extinguishes the lamps.

(4) If it is required to extinguish some of a series of lamps fitted with automatic lighters before the others, and all of the lamps take their supplies of gas from the same main, each of the lamps to be extinguished earlier than the others must be provided with a lever cock so arranged that it can shut off the supply of gas to the burner without shutting off the supply to the pilot light which is controlled by the automatic lighter. This arrangement entails two visits to each lamp fitted with the additional lever cock, the first to turn off the light and the second to reopen the closed cock before the next lighting-up time. This system is suitable for single-burner high-pressure gas lamps and also for multiple-burner lamps, when all of the burners in each lamp are put under one control, that is to say, when the whole of the burners in each lamp are required either to be alight or out during any specified periods.

(5) It is sometimes desired, when high-pressure gas lamps fitted with several burners are used, to have all of the burners in each lamp alight during certain periods of the day and then to reduce the number of burners alight during other periods. For example, it is not infrequently the case that street lamps, each fitted with several burners, are kept fully alight until midnight, after which time the number of burners left alight in each lamp is reduced. This requirement can be met in two ways, each of which makes it possible to have any desired number of burners in or out of action :

(*a*) In the first system the supply to the burner or burners kept longest alight is fitted with a governed flashing by-pass cock, and the supply to the other burner or burners is controlled by a plain lever cock. This combination, of course, entails a visit to each lamp for each operation, that is to say, one visit to light up all of the burners in the lamp, a second visit to extinguish some of the burners, and a third visit to extinguish the remaining burners.

(*b*) In the second system a combination of automatic distance lighting and a lever cock is so arranged that, while *all* of the burners can be lighted up and extinguished in series from a distance, some of the burners may be extinguished if desired by shutting the cock controlling them. This arrangement involves two visits to each lamp, one to reduce the number of burners alight, and another to reopen the closed cock before the next lighting-up time.

The special valve used in lighting-up or extinguishing lamps individually, or groups of lamps when fitted with

automatic lighters, is illustrated in Fig. 2, and is arranged to turn on the pressure in two stages, in order to ensure that the flash is in operation slightly before the gas supply reaches the mantles. This valve is fitted with a special by-pass governor ,which keeps the size of the pilot light or lights constant, whether gas at low or high pressure is in the mains.

The methods of controlling high-pressure gas lamps having been described, all that remains to be done is to explain the action of the automatic lighter which is fitted to each lamp when it is controlled with others from a distance.

Fig. 3 shows a sectional elevation and a sectional plan of the apparatus. The use of the appliance is confined strictly to cases in which there is a considerable difference between the normal pressure and the high pressure in the main. The apparatus consists of a valve body (A) and a cover (B), between which is held a thin metallic diaphragm (C). This diaphragm is made of pure silver, which is the most satisfactory material for the purpose, as it does not readily corrode and does not flake with heat. The valve seat (D) is formed in the body (A) so that the centre of the diaphragm bears upon it. The diaphragm (C) is held normally on the seat (D) by a plunger (E), which is actuated by a spiral spring. The power of this spring can be increased or decreased by screwing the screw (R) inwards or outwards.

The gas enters the annular space between the diaphragm and the valve seat by the passage (F), and so long as the gas pressure is insufficient to overcome the resistance of the plunger (E), no gas will pass to the outlet. When the high pressure comes on, however, the diaphragm and plunger are forced back to the position shown in the plan, allowing the gas to flow through the valve seat (D) to the outlet. When the pressure is reduced again, the diaphragm closes by the action of the plunger, and the gas is again cut off.

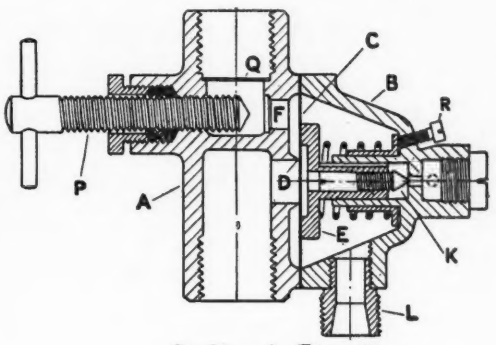
It will be obvious that the pilot light, which it is necessary to use with such an apparatus, must be controlled, as otherwise, if adjusted to a reasonable size under the low pressure, it will increase to an abnormal size when the lamp is alight, which, apart altogether from the waste of gas, is objectionable. The movement of the diaphragm is used to counteract this increase, and at the same time to make use of it to give a temporary " flash " at the moment of lighting. A small port (G) is formed, leading from the annular space, which is always open to the gas supply. This port is connected to a corresponding passage, which leads to the back of the cap into the space (H). On the end of the plunger (E) is fixed a small valve (K), which shuts against its seat when the diaphragm is in the open position. When the diaphragm is closed, a passage is left through this seat into the interior of the cap (B), and from thence to the union (L) to which the by-pass is connected. The regulating screw (M) is so adjusted as to allow the correct amount of gas to pass under low pressure through the port to the by-pass.

It will be seen that, when the pressure begins to increase, the amount of gas which will pass the regulating screw (M) is also increased, so that the pilot flame begins to increase in length. This goes on until the diaphragm opens sufficiently far to press the valve (K) on to its seat, which cuts off entirely the supply to the by-pass from this source.

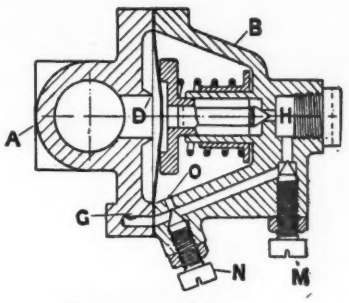
In order to allow the small pilot light to be kept burning while the lamp is alight, to prevent the pilot tube becoming filled with air, and to ensure the pilot being alight when the lamp is turned off, a second adjusting screw (N) is provided, which controls a small port (O) leading directly into the cap (B). This is so adjusted that the amount of gas which will pass through the port (O) at high pressure is just sufficient to give a small light on the pilot.

It is desirable to ensure that the diaphragm (C) finds its seat accurately on the valve seat (D) ; a circular depression is therefore made on the face of the plunger (E) of larger diameter than that of the valve seat, so that the metal of the diaphragm can accommodate itself to the seat.

In order to be able to shut off the lamp entirely without requiring a separate stop cock, a screw-down valve (P) is fitted, which is adapted to close the opening (F). This works through a stuffing box packed with asbestos cord,



Sectional Elevation



Sectional Plan

FIG. 3.—Sectional elevation and sectional plan of the automatic lighter fixed to to each high-pressure gas lamp when the lamps are lighted up and extinguished in series by the turning of the valve shown in Fig. 2, or by the starting-up or stopping of the compressing plant.

and is turned by means of a tee handle, so that it can be easily opened or shut by hand. This arrangement enables the cap (C) to be removed and the diaphragm examined at any time while the pressure is on, without interfering with the remainder of the installation.

The gauze (Q) is fitted on the inlet to prevent any dust or dirt getting into the valve seat.

These valves are sent out properly adjusted for say 2 or 3 inch water column on the low pressure and 6 inch mercury column on the high pressure. If it is found necessary to adjust the pilot light, this is done in the following way : When the lamp is on low pressure, the screw (N) is closed and the pilot light is adjusted to the correct size by means of the screw (M) ; the locknut is afterwards screwed up tight. The pressure is then turned on and the lamp lit, and the pilot light should be extremely small, or be entirely cut off. The screw (N) is then opened very slightly so as to give a very small flame on the pilot, and is finally fixed by the locknut.

The automatic distance lighting appliances described in the above notes are very reliable in action and are in use in some of the most important streets in London and other cities and large towns in this country and abroad.

Friendly Relations with Consumers*

It should be realized everywhere that, unless undertakings are on friendly terms with their consumers, they are going to be severely handicapped. It is now very generally realized—as it should be universally—that the " take it or leave it " attitude is out of date. Friendly relations are the basis of all good business; and naturally it follows that gas undertakings must give satisfactory service. It is no use to think that because the appliances and methods of supply of twenty years ago satisfied a community they will do so now. To-day people demand the best that is procurable. One must not necessarily conclude that because no complaints are forthcoming people are satisfied. It is for each one to look at his own business, and see whether that business is being conducted on up-to-date lines, and whether it is really supplying the article that is wanted.

* Extract from the Address of Mr. D. Milne Watson (President) at the Annual General Meeting of the National Gas Council.

An Example of Modern Library Lighting

THIS good example of modern methods of lighting public libraries is reproduced from a recent issue of *Holophane Illumination*. It will be observed that illumination is provided by gasfilled lamps in Holophane Reflector Refractor Units, which, whilst giving well diffused general lighting, are designed to concentrate the greater part of the flux of light in a downward direction.

In public libraries a distinction has usually been drawn between the requirements of reading rooms and students' reference libraries. In reading rooms, as in this case, general lighting is usually preferred, both in regard to cost and convenience, and because a bright and cheerful effect is desired. The "cheerfulness" should, needless to say, be attained without "glare," and the illumination should not be less than 3 foot-candles and preferably somewhat more.

FIG. 1. Night Photograph showing method of lighting in Ipswich Library.

In the reference library, devoted to the requirements of students, more serious reading is undertaken. A "studious" atmosphere of tranquillity is desired. Therefore one finds that librarians often prefer local well-shaded reading lamps, supplemented by moderate general illumination. The use of local units has here the additional advantage that one can economically obtain relatively high illuminations with a minimum of 5 foot-candles, and the arrangement permits only lamps at those tables actually in use to be switched on. This is a consideration to the librarian, as there are often periods when the library must be kept open though the attendance in the Students' Reference Section may be small. Reading rooms, on the other hand, are made use of more continuously so that general lighting is economical and convenient.

Recently the use of efficiently designed enclosing glassware units—either totally enclosed or with a small aperture at bottom, has become popular for such general lighting. There can be no question but that diffusing units, such as those shown in this illustration, are much to be preferred to the old shallow opal shades, often used with bare lamps and serving as very inefficient shading devices.

Furnished House as Prize

R.A. DESIGNS DWELLING FOR NOVEL COMPETITION.

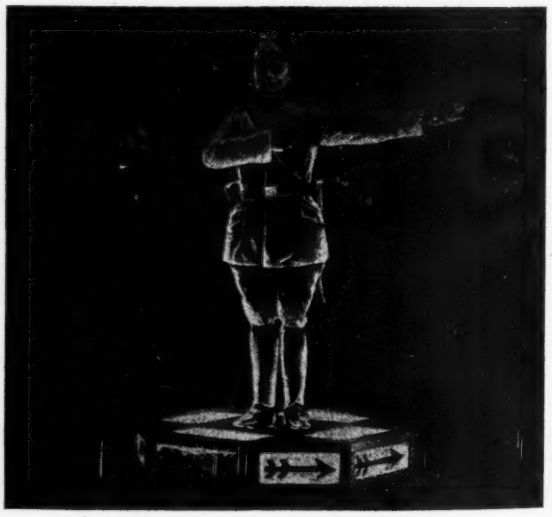
A novel form of competition, which will be of interest to many trades, is being organized by *The Sunday Chronicle*. The prize will consist of the freehold of a new house, completely furnished and decorated as the winner may decide. The site is in Kingsbury, on the north-west outskirts of London.

Sir Reginald Blomfield, R.A., the architect, has designed the house on Georgian lines, and shows the value of concrete construction in domestic architecture. The building, from foundations to roof-tiles, will be entirely of concrete. An interesting feature is the columned loggia of reconstructed stone. When finished, the house will be thrown open to the public. At the time it will be unfurnished and undecorated—except that the hall and dining-room will be panelled in plywood. The walls of the other rooms will remain bare.

Visitors will then be invited to submit schemes for the decoration and furnishing of the house. For their assistance they will have access to the catalogues of various firms of dealers in furniture, upholstery, carpets, pictures, hardware, etc. Any article selected must be chosen from the catalogue of one of the firms mentioned.

The individual whose scheme is adjudged the best will receive the house completed, fitted and furnished as suggested in his scheme.

A Luminous Traffic Guiding Device



The above illustration shows a very practical form of luminous equipment for aiding the guidance of traffic, which has lately come into use in some German cities. The small island here shown is fitted with robust panels of diffusing glass, some mounted vertically round the edge whilst others are horizontal rectangular lozenges set in the horizontal surface, which is a few inches above street-level. Below the surface electric lamps equipped with reflectors are mounted, so that at night the various glass panels become highly luminous.

The vertical panels carry arrows indicating the direction of flow of the traffic. The horizontal panels serve to throw a strong upward light which illuminates the figure of the traffic-officer standing on the island so that all his motions and directions can be clearly seen.

The Economic Use of Electric Light on the Farm with Particular Reference to Poultry*

By R. BORLASE MATTHEWS, Wh.Ex., A.M.Inst.C.E., M.I.E.E., F.R.Ae.S.

IT is the universal experience of electricity supply authorities that as soon as electricity is available in an agricultural district the first thing that is done by the farmers is to light the byres and stables. In many cases these outbuildings are thus lighted long before the farmhouse. Why is this? The answer is simple—because it pays.

The author's experience, on his own farm at East Grinstead, has shown that the installation of electric light in the cow byres has practically stopped the milk loss through spillage, and the value of the milk in one way or another, so saved, is more than the total cost of the current used. Again, careful tests have demonstrated that good lighting means a saving of half an hour a day in the feeding of livestock. This is not an inconsiderable amount when totalled up over the year.

The use of electric light as the only illuminant on the farm adds greatly to the safety and convenience of work in barns, byres, stables and yards. It is often necessary to do work before and after daylight, and the unsafe oil lamp is both dangerous and unsatisfactory because of its limited range of light and the danger of fire. Owing to the distance of the average farm to the nearest fire station, a fire usually means a total loss of stock and buildings. The upsetting of a paraffin lamp has caused many farm fires. Every farmer's wife knows only too well that there is considerable daily labour in filling and cleaning oil lamps.

It is difficult enough to get men to turn out for milking at 4-30 a.m. Now electric light provides more comfortable working conditions, hence the electrically lighted farm will always have preference from the milker's point of view, especially as he can get his work done more quickly and easily. Besides, the electrically lighted farm will soon be a farm upon which are installed electrically operated milking machines.

That electricity is needful for the comfort of every home is a fact that is seldom disputed, but that there are only about 20 per cent. of the houses of this country electrically lighted is a fact not often realized. The explanation of this low figure is in part accounted for by the lack of facilities offered to rural dwellers and in part by want of appreciation on the part of many people that every householder *can* afford it. In fact there are very few who can afford to be *without* it, and the farmer is certainly among these latter.

The use of electric light on the poultry section of the farm, for the stimulation of egg production during the winter months, is another very practical and profitable application of electric light on the farm. It has now passed the experimental stage and the majority of the poultry farms in America are electrically lighted, while most of the larger commercial poultry farms in England are now producing increased supplies of winter eggs in this way. Careful investigation shows that the hens do not lay more eggs per annum, but the distribution of the laying period is altered, with the result that 20 to 30 per cent. more eggs are obtained at a time when eggs are at their highest price.

At first sight, it may appear strange that artificial light should have any effect on egg production, but there is quite a logical reason why the lengthening of the day increases the supply of eggs. The number of eggs produced by a hen is dependent upon the activity of the bird and the amount of food consumed. The hen cannot consume more than the crop can hold, and at the end of a very few hours the crop of a normal hen is empty. On the other hand, a hen will not go to roost until her crop is full—providing there is sufficient light for her to see to get the food. It is well known that the supply of eggs is considerably decreased in the winter time; this is due to the fact that a good deal more than half of the twenty-four hours is spent on the perches, and during this time the hen has digested all her food and is afterwards drawing on her stored fats, instead of utilizing them for egg production. If the houses are illuminated by electric light, so as to reduce the hours of sleep to about ten every day, the birds will thus be kept active for fourteen hours, and will also have a longer period for consuming food. The introduction of this system does not mean that the hen will be overworked, for the hen is of sub-tropical origin, where the length of the days and the nights are practically the same.

The hours at which the lights are introduced vary according to the opinion of the poultry-man, and local circumstances such as the prevalence of rats and mice. Some only light the houses in the early morning before sunrise, and others prefer only evening lights, while others divide the time, giving part in the morning and part in the evening. Still another method is that of the evening supper—a short interval at about 9 p.m. or 10 p.m. for concentrated feeding. The author's experience has led him to adopt the combined morning and evening method as the most convenient and satisfactory.

As birds respond favourably to kindness and regularity, so they also respond unfavourably to carelessness and sudden changes. Hence, once artificial lighting is started it should be continued regularly, or else the birds are liable to be thrown into a moult.

A suitable light must be provided in the houses. A 40 candle-power lamp, placed in a scientific reflector of the light-distributing pattern, will be sufficient for sixty birds. Though it is possible to obtain this intensity of light from other sources, the ease with which electricity can be controlled makes it the only illuminant which will enable the farmer to adopt this new method with a minimum of expense.

When electric light is used, time switches can be installed, which will dim the lights for about fifteen minutes before switching off, so as to allow the birds sufficient time to get on their perches. In the morning the dimming arrangement will be operated for about fifteen minutes to produce an artificial dawn. By the aid of automatic time switches no extra labour is required as the clock will carry out all the necessary operations. The author has a clock on his farm with an astronomical attachment which automatically switches on and off a few minutes earlier or later each day in accordance with the earlier and later rising or setting of the sun.

Careful records have been kept on the author's farm, and it has been found that the total cost of the electric light for the whole period amounted to about the average price of one egg per hen per annum. Or, in other words, a unit of electricity will light one hundred birds for three days.

For testing the fertility of eggs in an incubator, there is nothing like "candling" them with a powerful electric lamp. An entirely new application of electric lamps is to prevent the crowding of young birds together at the side of a cold brooder house by suspending a lamp in the centre, near the floor. The good result thus obtained is due to the fact that the lamp and its slight warmth attracts and keeps the birds in the middle of the building.

Another interesting application of electricity on the poultry farm is to be found in the use of ultra-violet or invisible rays.

While few experiments have been carried out so far in this country, sufficient has been done in other countries to show that there are far-reaching possibilities in this direction.

The lamps generally used are either arc or quartz mercury-vapour lamps, the light of which contains about

*Abstract of a paper read at the Second British Electro-Farming Conference (on the occasion of the Royal Agricultural Show) held under the auspices of the British Electrical Development Association, at Reading, on July 8th, 1926.

28 per cent. ultra-violet rays, which is four times more ultra-violet light than is radiated by the sun.

Young chicks under this treatment for twenty minutes each day for two months attain the size of three-months-old birds, and are ready for the market at least five weeks before untreated chicks. The death rate among treated chicks is reduced by more than fifty per cent., while weak legs and rickets are entirely eliminated.

Experiments have also been conducted to determine the effect of ultra-violet light on laying hens, and it has been found that, in one case, hens give a ten-minute ultra-violet radiation daily during the winter months laid 140 per cent. more eggs than untreated birds in a control pen. The exposure of any bird to ultra-violet light, whatever its age, should not exceed twenty minutes per day and should be started with about ten minutes.

As a matter which will interest the market gardener and horticulturist, it may be mentioned that the author has carried out a number of experiments on the influence of very intensive electric light on the growth of plants. It has been definitely shown that really intensive artificial light will accelerate germination, give greater depth of colour, increase growth, and speed up flowering without any of the unsatisfactory signs that are usually found when artificial forcing is carried out.

The author's experiments were confined to the ordinary plants which are usually to be found in greenhouses. Daffodils and Lent lilies, when placed under the light of 1000-watt Mazda lamps and reflectors for six hours a night, flowered in four days, growing about three-quarters of an inch a day. Narcissi flowered in seven days. The control plants, placed away from the light, took four weeks to flower. The buds on azalea plants will open out fully in a night. Further experiments have shown that when transplanted seedlings are exposed to intensive illumination for one night they do not wilt as is the case in the usual way, but actually put on a week's growth and are exceptionally strong and healthy. A one-night treatment to every plant in a greenhouse brings about a marvellous progress.

Electricity is sold by the Public Supply Undertakings at so many pence per unit. However, the term unit does not convey much to the lay mind. In fact—be it whispered—very few engineers have a really clear understanding as to what is a unit. The best and the most practical way to comprehend what this term means is to note what this unit will do. When used for lighting, it is about equivalent to a gallon of paraffin oil. It will provide 25 hours' light in the farm kitchen or sitting-room or 50 hours' light in the bedroom, barn or byre.

When electric light is installed on a farm, it does not take long before other conveniences are added, such as an electric washing machine, an electric sewing machine, or a vacuum cleaner. The motor on the machines only consumes as much current as one or two lamps, hence they are very cheap to operate. In fact they are infinitely economical when the work they will accomplish is considered.

Finally, as the conclusion has been arrived at as to the supreme advantages of electric light the question arises as to how it is to be obtained. Fortunate indeed is the farmer who is within reach of a public supply. If the nearest supply point is some miles away, a little co-operation with his neighbours will soon bring it in his direction. Every farmer who has not already got electricity available will have an oil engine. An electric generator can be purchased quite cheaply that can be driven by this engine just like any other piece of barn machinery. If the engine is of such a type that it does not produce a steady light, or if it is too large to run just for lighting purposes only, then a battery should be added. The use of the latter means that electric light is available at any time of the day or night—which is a great convenience. Possibly an old water-mill may be available; if so, this should be considered for driving the electric generator.

Anyhow the best advice that can be given to any farmer, judging from the experience of those who have had an opportunity of testing its benefits, is to get an electricity supply on his farm, somehow or other. Firstly, because it pays, and, secondly, because it adds greatly to the comforts of life. After all, why should not the country dweller have some of the advantages of the townsman.

Opportunities for the Use of Light in Fruit and Flower Culture

THE paper by Mr. Borlase Matthews, reproduced above, surveys in a general manner the opportunities of electric lighting on the farm, and refers to some experiments showing the value of intensive lighting in horticulture. It is probable that a great deal has yet to be learned as to the effect of light on growing vegetation. That growth of plants can be stimulated by supplementing natural by artificial light seems to be well established, though the commercial possibilities of the process need to be worked out. It seems clear, however, that we need to know much more about the quality of light and radiation desired of certain forms of plants. Whilst, broadly speaking, a spectrum similar to that of average sunlight may be desired, it may be that the stimulating effect is concentrated mainly in certain parts of the spectrum. Of special interest is the effect of the rays immediately beyond the visible violet—the "long wave" ultra-violet, which appears to be now regarded as the most valuable section for medical treatment. It has been contended that the absorption of such rays by the ordinary glass used for greenhouses is a great drawback, and experiments with the new "Vitaglass," which permits their passage, are now being made. There is also the suggestion, referred to elsewhere in this number, that polarized light has a specially stimulating action on plants. This is an effect which requires confirmation, but ought not to be very difficult to check, as abundant polarized light can be readily produced by reflection methods.

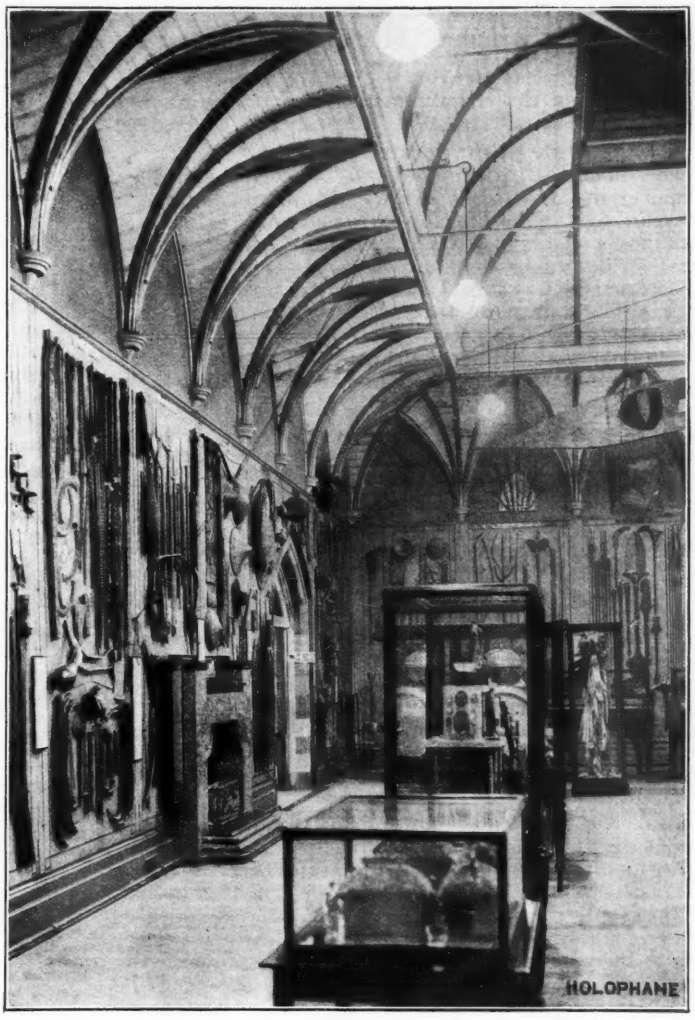
Experiments have also been made on the effect of light in assisting germination of seeds. It has been shown that the growth of seedlings is hastened by the use of intensive artificial lighting, which has also enabled glass lawns to be grown very much more rapidly. The stimulation to growth might be expected, but it seems difficult to explain how the application of light can assist the *germination* of a seed buried perhaps half an inch or more in the soil. Possibly in such cases it is the radiant heat that is most effective in encouraging germination from the source, though naturally the light may begin to act once the seed has germinated and a shoot appears above the earth.

Of special interest is the effect of light on advanced culture of choice fruits. The economic possibilities of light-treatment seem to lie chiefly in the development of fruit for market at out-of-season periods. Very early strawberries, for instance, fetch a fancy price. But hitherto it has often been found that these early hothouse products lack the full flavour of fruit grown naturally in the open. By some people this is now attributed to the fact that the forcing process is largely a matter of temperature, as the plants lack the stimulus of sunshine, and especially the ultra-violet light. This element could be made more available by the use of special glass for greenhouses, transparent to these rays. But in early spring there is in any case only a limited amount of ultra-violet radiation available in this country from sunlight, and it may therefore be necessary to supplement this by artificial means. It has been stated that owing to the lack of early sunshine this year strawberries have lacked something of their full flavour. A special example of the influence of light on flavour seems to be furnished by bananas which are imported in the green state and artificially ripened by heat. The writer has been assured that the flavour of the banana, grown naturally in the tropics and plucked from the tree, is very different from that associated with the artificially ripened variety.

It is obvious that future possibilities in this direction depend primarily on a cheap and abundant supply of electricity being available for lighting. But meantime there is room for experiment in determining the range of radiation which is most useful.

Efficient Lighting in Museums

MUSEUMS, like libraries, have surely a special claim to adequate artificial lighting. In some cases artificial lighting is not taken very seriously because the museum is in general open during daylight hours. But in the case of exhibits of national interest it may well be urged that most people are occupied by day, and that it is only in the evening that some are free to visit museums. In the case of priceless collections there is the important question of danger of fire, which has sometimes deterred authorities from making full use of artificial lighting. But provided the installation is carried out on modern and efficient lines, and maintained in good order, this risk is not very great. There is also the fact that exposure of the contents to light does tend to increase the fading of colours of many objects—a point raised in a paper before the Royal Society of Arts a few years ago. But the available experience shows that most artificial illuminants are at least less destructive in this respect than sunlight, and even than diffused daylight. Also, as was pointed out in the discussion referred to above, these collections, however priceless, should be enjoyed by the present generation, even at some risk of deterioration. We must not be so concerned with the safety and preservation of exhibits for posterity as to restrict opportunities for objects to be seen and admired by people now alive and able to enjoy them.



Showing lighting in a part of the Ethnographical Collection, Royal Albert Memorial Museum, Exeter.

However, in some cases, those in charge of museums are inconsistent. They admit the necessity of artificial lighting, but usually on grounds of economy do not always furnish illumination worthy of the object. The lighting of museums presents many special problems. Besides those mentioned above there is the question of proper display of the colours of objects, a point of obvious importance in the case of pictures, tapestries and coloured fabrics, and also in the case of many minerals, and exhibits of birds and animals. Artificial daylight of an accurate type may prove unduly expensive for general use, though cases containing certain objects might well be illuminated by this means when the correct appearance of colours is essential to the proper appreciation of the things shown. In other instances lighting by some of the methods which approach daylight in colour, without the sacrifice of light necessary to secure great accuracy of imitation, may be considered. The use of these modified forms of artificial daylight is the more to be recommended because, during the dull winter days and as evening approaches, a mingling of artificial light with daylight is usual. Partial failure of daylight may only involve the lighting up of the darker parts of the room, not the entire area.

Finally, in a museum the fundamental principles of all good lighting apply with special force. The whole object of the museum, the interest it excites and its educational value, depends upon the objects exhibited being *seen*. There must therefore be ample illumination, coupled with the avoidance of glare. The large rooms in which exhibits are housed are apt to be underlighted; such rooms need to be flooded with light so that everything can be closely examined and minute details seen. There are also frequently cases where the local lighting, by concealed lamps, of special showcases deserves consideration. But general lighting with diffusing fittings usually answers requirements, and the accompanying view of a part of the Ethnographical collection at the Royal Albert Memorial Museum, Exeter (reproduced from *Holophane Illumination*) gives a good idea of such methods. The choice of well-designed diffusing light units for general lighting also deserves consideration because of the important part played by shadows. In a picture gallery we are concerned only with flat surfaces. But in rooms devoted to such objects as carved furniture, statuary, china and porcelain, etc., unduly harsh shadows caused by imperfect diffusion of the light may interfere very greatly with the effectiveness of the exhibit.

Advances in the Lighting of Tea Shops

To the young generation the multitude of tea shops available and constantly increasing in London and other large cities is a familiar feature. But there are many older people who can remember when there were practically none, and when the first pioneering shops opened by leading caterers were a complete novelty and a surprisingly successful one. Recent years have been marked by a continuous advance in the comfort and efficiency of such establishments. The lighting and general style of decoration of shops of the leading caterers has been very much improved. One significant change is the adoption of overhead enclosed fittings of diffusing glassware, some of a pleasing decorative type, which represents a great advance over the original shallow opal shades and bare lamps, both as regards amount of illumination and freedom from glare. A distinctive style of exterior lighting, applied to all its branches, is a most valuable advertisement for a multiple-shop concern. The educational value of a wholesale change of this kind is also considerable, as rival establishments are driven to "sit up and take notice."

The Royal Sanitary Institute Jubilee Congress

Held in London, July 5th—10th

THE congress of the Royal Sanitary Institute, held in London this month, marked the Jubilee of the Institute, and the papers and addresses covered a wide range.

The inaugural address by the Rt. Hon. Neville Chamberlain, Minister of Health, contrasted conditions 50 years ago, when the Institute came into existence, with those prevailing to-day. Sanitary science has made great strides. The founding of the Institute was not an isolated fact. The Public Health Act, passed in 1875, still stands as the foundation of our public health legislation. Mr. Chamberlain laid special stress on the educational work of the Institute. An informed public opinion is essential to progress in matters of health.

Addresses were also delivered by those presiding over the various sections of the congress. Sir George Newman, in addressing the section of Sanitary Science and Preventive Medicine, drew attention to the efforts of many non-medical workers who have contributed to advances in medicine. Amongst these may be numbered philosophers such as Aristotle, Roger Bacon the Franciscan monk, and Galileo. Something also is due to the work of great artists such as Albrecht Durer and Leonardo da Vinci, who studied anatomy in detail, and to very many physicists and scientists, whose discoveries have been applied in medical work. During the last 300 years progress has been aided by many advantageous changes in custom—the abolition of the wig and trailing skirt, and of the mischievous window-tax, the more general participation in outdoor games and greater fondness for fresh air and sunlight, and the greater public knowledge of simple hygiene.

Lord Eustace Percy's address on School Hygiene emphasized the aim of the Institute as the prevention rather than the cure of disease, and in this connection he contrasted modern school buildings, designed on open-air lines, with the old, ill-adapted, ill-ventilated and ill-lighted buildings of the past. Secondly, he drew attention to the part played by physical training, organized games and out-of-door activities. Thirdly, he pointed out that the School Health Service aims at fostering knowledge of hygiene amongst parents and others responsible for the care of children—not of removing children from the home into an institution. The address to engineers and surveyors was by Mr. G. W. Humphreys, and that to sanitary inspectors by Sir William Collins, who quoted Chadwick's definition of liberty: "Liberty consists of the power of doing anything which does not hurt another."

There were upwards of 60 other papers and discussions on the programme, which covered a wide field. Lord Riddell dealt with "The Press in Preventive Medicine," and there were discussions on Public Health Propagandism, House Construction, Sewage Treatment, Food Preservation, etc.

The Rt. Hon. J. R. Clynes gave an address on "The Human Side of Industrial Welfare," and Professor I. E. L. Collis dealt with the Factory Medical Service. There were also many social events and visits.

The congress, therefore, served to illustrate the ramifications of sanitary work of to-day. There was only one omission that strikes one as singular—that in such a comprehensive series of papers dealing with all aspects of public health there was little or no reference to the influence of *light*, natural or artificial, which bears such an important relation to health and hygiene.

We hope that at the next annual congress more will be heard of the part played by light in connection with sanitary hygiene. Lighting is associated with many of the subjects discussed. In the home and in the school good natural and artificial lighting exercises an important influence on health and vision. In industry it is now regarded as essential, in the same way as adequate ventilation, heating and sanitation. And in the treatment of many diseases with which sanitary inspectors and hygienists are concerned the use of natural and artificial sunlight already plays an important part.

Precautions Necessary in Testing Colours

"ARTIFICIAL daylight" units, which were only introduced a few years ago, are now being widely employed by trades concerned with colours, and the more accurate and scientifically designed units are now proving of considerable value. The necessity for accuracy in imitating "average daylight" is rightly insisted upon, but there seems to be a good deal of misunderstanding of the subject, even on the part of those whose occupation consists in judging delicate colours. The extreme variations in daylight and the difficulty in deciding what constitutes "normal" or "average" daylight are not always appreciated. A "north light" is often regarded as the ideal, but many workers with colours consider this too blue.

Apart from variations in the spectrum of daylight, owing to varying climatic conditions, effects of clouds and mist, dust in the atmosphere, etc., there are local factors which are often surprisingly ignored. The writer recalls a comparison of an artificial-daylight unit with natural illumination, made in a room in which the sky itself was not visible at all! The "daylight" so-called was derived entirely by reflection off the faces of buildings opposite, in this case consisting of yellow brick. Needless to say, the artificial-daylight unit showed marked departure from this form of daylight. Other cases occur in which the light entering a room consists largely of rays reflected from the foliage of adjacent trees, and is therefore appreciably green. Naturally also light suffers a selective change when passing through exceptionally grimy dust-laden windows. Further, the effect of surroundings in the room itself are material. It is disconcerting, after having the need for extreme accuracy impressed on one, to find that tests are being made in a room with bright yellow walls.

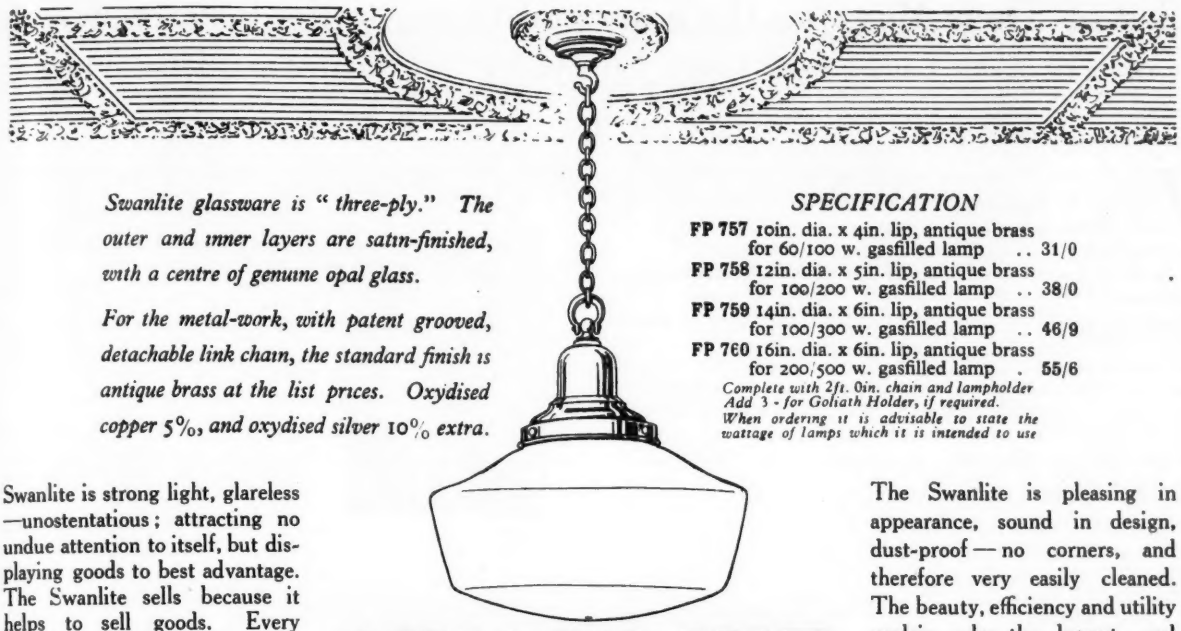
All these may seem elementary facts, but they are not always appreciated. Lastly, there is the element of uncertainty derived from the eye itself. The impression of a colour depends to some extent on the part of the retina on which an image is received. Hence two colours which match at arm's-length may no longer match when brought quite close to the eyes. Strictly speaking, in standardizing work it is necessary to specify the intensity of illumination and the angle subtended by the coloured surfaces at the observer's eye.

Literature on Selenium

A glance at *The Bulletin of the New York Public Library* for June, 1926, reveals a useful record of literature bearing on selenium during the period 1817-1925. Thirty-seven chief works, derived from the United States, Germany, France, Italy, and Great Britain are mentioned, the last on the list being one of Mr. Fournier d'Albe's recent contributions. This is an opportune illustration of the list of special works published in this *Bulletin* from time to time and example of enterprise by the New York Public Library.

Is the University Trained Woman Worth Employing?

A pamphlet with the above title has been issued by the Business and University Committee, whose Hon. Secretary, Miss C. Haslett, is also secretary of the Women's Engineering Society. It is contended, and with reason, that higher education and university training enables a woman to grasp a job more quickly and to take a wider view. She has passed through a course of mental discipline, and has often special qualifications for business work. The Business and University Committee is intended to act as a link between the employer and the educated woman, and can put firms in touch with women who are expert mathematicians, linguists, chemists, historians, physicists, etc.



Swanlite glassware is "three-ply." The outer and inner layers are satin-finished, with a centre of genuine opal glass.

For the metal-work, with patent grooved, detachable link chain, the standard finish is antique brass at the list prices. Oxydised copper 5%, and oxydised silver 10% extra.

SPECIFICATION

FP 757 10in. dia. x 4in. lip, antique brass for 60/100 w. gasfilled lamp .. 31/0
FP 758 12in. dia. x 5in. lip, antique brass for 100/200 w. gasfilled lamp .. 38/0
FP 759 14in. dia. x 6in. lip, antique brass for 100/300 w. gasfilled lamp .. 46/9
FP 760 16in. dia. x 6in. lip, antique brass for 200/500 w. gasfilled lamp . 55/6

Complete with 2ft. 0in. chain and lampholder Add 3 - for Goliath Holder, if required. When ordering it is advisable to state the wattage of lamps which it is intended to use

Swanlite is strong light, glareless —unostentatious; attracting no undue attention to itself, but displaying goods to best advantage. The Swanlite sells because it helps to sell goods. Every Swanlite is another efficient sales help — and with this lighting efficiency there is true beauty of design.

The Swanlite is pleasing in appearance, sound in design, dust-proof — no corners, and therefore very easily cleaned. The beauty, efficiency and utility explain why the largest and most progressive Stores, Hotels and Restaurants are now Swanlite—ing.

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The Dust-proof Unit
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EVERYTHING ELECTRICAL

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123-5, Queen Victoria Street, London, E.C.4

Wanted—A Definition of "New Business"

Many statistics are available to show the rapid and continuous increase in the consumption of electricity for various purposes. In the United States, it is reported, the number of residential consumers has been increasing at the rate of over 10 per cent. per year. Commercial consumers, at least in some localities, are increasing equally rapidly. The problem raised by *The Electrical World* is how far this increase is a natural development and how far it is "new business" that is created by the energy and effort of the sales departments. It is suggested that strictly new business might be defined as the increase in consumption of electrical energy per consumer, other conditions remaining unchanged. The point might well be taken up in this country. There is a natural and progressive increase in the use of electricity and this in a way makes the task of the selling organization correspondingly easy. But there is the danger that undertakings so happily situated may be content to rest on their oars, instead of contributing, by active propaganda, to the increase in genuine "new business," as compared with the natural advance in the use of electricity, which is natural and not actually the result of commercial enterprise.

There is also this point to be considered, that efforts after "new business" conducted on a co-operative basis, such as those being made by the E.D.A. and the E.L.M.A. Lighting Service Bureau, react to the benefit of all sections of the electrical industry. The influence of such movements is widespread, and individual firms or undertakings who benefit are not playing the game unless they contribute and assist the efforts being made on their behalf.

Floodlighting of the Monument on Bunker Hill

The United States seems to be making wide use of floodlighting to reveal historic monuments by night. One of the latest examples is the illumination of the famous Bunker Hill monument in the Charlestown section of Boston. This long and slender tower is illuminated by six 18-in. incandescent searchlights with 40 spread prismatic lenses; 110-volt and 1,000-watt lamps are used. The lamps are placed on poles arranged round the monument, so that two out of the four sides are lighted by each set of searchlights. One pole is 250 feet away, the other 190 feet away from the monument. The fact that in this case it has been found possible to illuminate from a distance is a manifest advantage, in view of the great height of the monument (221 feet).

Glass Technologists at the G.E.C. Wembley Works

Some seventy members of the Society of Glass Technology visited the Osram Glass Works and the G.E.C. Research Laboratory at Wembley on June 2nd. The party included Sir Charles Parsons, Mr. Walter Butterworth (President), and Professor W. E. S. Turner (head of the Glass Technology Department at Sheffield University, and Secretary of the Society). After the works and the laboratory had been inspected a vote of thanks was proposed by Mr. Butterworth. Mr. C. C. Paterson replied. The party afterwards adjourned to the library, where papers were read by Mr. Ryde, of the staff of the G.E.C. Research Laboratories ("Opal Glass"), Mr. Bryson ("Electrical Conductivity of Glass at High Temperatures"), and Dr. Turner ("The Influence of Moisture on the Rate of Melting and on the Properties of Soda-Lime Glasses").

Visit of Their Majesties the King and Queen to the Beckton Works of The Gas Light and Coke Company, on Saturday, July 10th

The Largest Gas Works in the World

"*I AM very glad to visit this old-established Gas Works at Beckton and to inaugurate the important additions to their plant, for I realize how essential the gas industry is to the daily life of the community.*"

In these few words His Majesty the King, on Saturday afternoon, July 10th, formally opened the new coal-handling plant at the Beckton works of the Gas Light and Coke Company. Pulling a lever, he set in motion the machinery on the river bank, which is able to unload no less than 2,000 tons of coal an hour. It is certainly the largest plant of its kind in Europe, and probably in the world.

The King, who was accompanied by the Queen, motored from Buckingham Palace by way of Queen Victoria Street, Cornhill, Leadenhall Street, Aldgate High Street, Commercial Road, East India Dock Road, Barking Road, and Beckton Road. With Their Majesties were the Countess of Minto, Lord Herschell, Lord Claud Hamilton, Sir Derek Keppel, and Captain the Hon. Alexander Hardinge. The royal party had an enthusiastic reception as they drove through the East End streets, and many thousands of loyal subjects lined the thoroughfares and heartily cheered their King and Queen as they passed by.

At Beckton hundreds of children stood outside St. Michael's Church, at the entrance to the works. For a moment the royal car was brought to a standstill, a choir of young voices sang the National Anthem, and little Florrie Dodds, the daughter of one of the foremen of the Company, presented Her Majesty with a bouquet of flowers.

Inside the works the King and Queen were received by Mr. D. Milne Watson (Governor of the Gas Light and Coke Company). There were also present Sir Arthur Steel-Maitland (Minister of Labour), Mr. Henry Woodall (Deputy-Governor), Mr. R. M. Holland-Martin, Colonel the Hon. Clive Bigham, Mr. T. Goulden, General H. B. Hartley, and Mr. R. J. N. Neville, M.P. (Directors of the Company), the Mayor of East Ham, and the Chairman of the Barking Urban District Council, all of whom had the honour of being presented to Their Majesties.

A brief inspection of the "Rangers" Battalion of the London Regiment, all employees of the Company, and a goodly company of ex-service men wearing their medals followed, after which five employees, each of whom has more than 50 years' service to his credit, were presented to His Majesty, as were also the members of the Co-partnership Committee and the Works Committee.

Then came the opening ceremony on the pier, which was witnessed by a large assembly of the Company's staff and their ladies.

Mr. Milne Watson said: "I desire on behalf of my colleagues on the Board and myself to express our high appreciation of the great honour Your Majesties have conferred upon this Company by visiting our works at Beckton to-day. This Company was founded in the year 1812, 114 years ago, by a Charter granted by King George III. It is the oldest gas company in the world, and it is also now the largest. An industry founded so long ago can only keep its place in the world by developing with the times and applying the discoveries of science and adopting modern methods. The new coal-handling plant is capable of unloading 2,000 tons an hour, and is the largest coal-unloading plant in Europe. I have much pleasure in asking Your Majesty graciously to pull the lever and start the plant."

The King having replied in the words quoted at the head of this account, and pulled the lever, the machinery was set in motion, and the King and Queen saw the coal delivered to the 6,000-ton hoppers by means of swiftly moving belt conveyors of a capacity of 1,000 tons an hour, the coal being automatically weighed in transit. From the hoppers it is distributed to the retort houses and storage beds by a railway system 60 miles in extent.

Mr. David Milne Watson, as President of the National Gas Council since its foundation and Governor of The Gas Light and Coke Company, occupies a pre-eminent position in the gas industry. He is an hon. member of the Institution of Gas Engineers, a Vice-President of the Illuminating Engineering Society, and a Past President of the British Commercial Gas Association. He is also prominently associated with many other bodies concerned with scientific and industrial problems.

Mr. David Milne Watson, M.A., LL.D., D.L.

In his several official capacities Mr. Milne Watson was of much assistance to the Government throughout the war, and served on various committees connected with the Ministry of Munitions, the Ministry of Food, and the Coal Mines Department of the Board of Trade. The honorary degree of Doctor of Laws of Leeds University was conferred on Mr. Milne Watson on July 3rd in recognition of his services as a leader of industry.

But the royal visit to Beckton was by no means over. Travelling in a special coach on the miniature railway, Their Majesties toured the vast works, and learned something of the scope of the undertaking. The Company supplies gas to an area of 265 square miles, extending from Windsor Great Park to Epping Forest. To provide the gas required for this purpose 2½ million tons of coal are carbonized in a year, and the residual products include 1,850,000 tons of coke, over 120,000 tons of tar, and 20,000 tons of sulphate of ammonia.

During the tour particular attention was paid to the enormous retort house and the chemical departments.

In the retort house the King and Queen watched the interesting process of the carbonization of coal, and looked at white-hot furnaces through blue glasses, this being necessary for the protection of the eyes. The heat was terrific, but this did not deter Their Majesties from seeing all there was to be seen, and asking many questions concerning the process.

Quite a while was spent in the chemical departments, and it was here that the royal visitors gave evidence of their practical appreciation of the domestic value of gas. One exhibit showed a ton of coal and its products, the latter including 7 cwts. of coke, 84 therms of mixed gas, 10 gallons of tar, 25 lbs. of ammonium sulphate, and 40 lbs. of clinker. These by-products are wasted when coal is burned in an ordinary fire. The exhibit led the Queen to comment on the wastefulness of the coal fire.

There were many interesting exhibits in this fascinating part of the works. Old iron refuse is transformed into the green crystals of copperas, and there is a veritable fairy palace of naphthaline, looking for all the world like gleaming snow.

Every year there is made at Beckton vast quantities of tar, pitch, creosotes, motor spirit, toluol, naphtha, pyridine, carbolic acid, bleaching powder, salicylic acid, sulphuric acid, and sulphate of ammonia.

There are nine big gasholders at Beckton, and the largest, which has a capacity of eight million cubic feet, is greater than the Albert Hall.

During the trip round the works the Queen discerned the golden cross of St. Paul's Cathedral glittering in the sunshine far away to the westward, and pointed it out to Mr. Milne Watson. It is interesting to note that this was the first occasion that St. Paul's has been seen from Beckton, and it was fitting that the first lady in the land should have been responsible for discovering that such a view was possible.

Later, Their Majesties drove to the excellent sports ground at East Ham provided by the Company for its employees, and close to the pavilion they planted a couple of slender poplar trees in commemoration of their visit.

TRADE NOTES & ANNOUNCEMENTS

THE PEARL MAZDA LAMP.

AN INTERESTING DEVELOPMENT IN LAMP MANUFACTURE.

Attention was recently drawn in this journal to the new method of frosting lamp-bulbs on the *inside*, a device which is regarded as having considerable advantages. In the "Pearl Mazda Lamp," introduced by the British Thomson-Houston Co. Ltd., we have the first-fruits of this investigation. The advantage of inside frosting is evident. Owing to the smooth outer surface the bulb can be easily kept clean, and it is also stated that the amount of light absorbed is less—only one-third to a quarter of that arising with outside frosting, even when the lamp is clean. When lamps have been in use for some time, owing to the tendency for exterior frosted surfaces to accumulate dust and dirt the advantage of inside frosting should be even greater.

The Pearl Mazda Lamp.

Hitherto the chief difficulty of this method of frosting has been to avoid undue weakening of the glass. This difficulty has, however, been overcome in the "Mazda" laboratories (where, it may be recalled, the original drawn-wire tungsten filament was also invented).

The advantages of the "Pearl Mazda Lamp" are summarized as follows: (1) reduction of glare to a minimum; (2) softening of shadows; (3) an absorption of light of less than 2 per cent.; and (4) ease of cleaning, owing to the outside of the bulb having an ordinary polished surface.

"Pearl Mazda Lamps" are made in 40, 60 and 100-watt sizes. At present the inside frosting is being applied only to gasfilled lamps. It is expected that there will be a very large demand for these lamps during the coming season, and resellers of electric lamps are advised to send in their stock orders at the earliest possible moment.

PUBLIC LIGHTING.

From the Wardle Engineering Co. Ltd. we receive some sheets showing typical forms of outdoor lanterns which we understand have been widely adopted for public lighting. Considerable variety is shown, some of the globes being of translucent and etched glassware, whilst other units are provided with prismatic glass. Robust construction and weatherproof properties form one of the main features of design.

SIEMENS "ZED" SAFETY FUSES.

Catalogue No. Z.110, now available from Messrs. Siemens and English Electric Lamp Co. Ltd., contains a very complete list of "Zed" fuses with particulars of distribution boards, etc. As usual, characteristic curves for 250, 500 and 750-volt cartridges and 500-volt and 700-volt types are included, the instantaneous fusing current required to blow the fuse in 0·1 sec. being shown. These fuses are well known as an exceptionally compact and convenient type, and the replacement is easy and expeditious.

THE GENERAL ELECTRIC CO. LTD.

REPORT FOR THE PAST YEAR.

The Report of the General Electric Co. Ltd. for the past year again shows a flourishing condition of affairs. The gross profits exceed £1,000,000 and a dividend at the rate of 7½ per cent. per annum is again declared. Further additions are made to the Reserve Account, bringing the amount up to £830,000. In the Chairman's address reference is made to the expansion in overseas trade, and the list of trade investments shows the great variety of associated engineering undertakings in which the Company is now interested.

NEW LIGHTING SCHEME AT MUSWELL HILL CONGREGATIONAL CHURCH.

A scheme of lighting, deserving of note, has been carried out at Muswell Hill Congregational Church.

Eight G.E.C. totally enclosed "Unalux" pendants of the "Shrewsbury" type are employed in lighting the body of the church, 200-watt Osram gasfilled lamps being employed in each fitting. Six "Superlux" fittings with white bowl-sprayed Osram lamps illuminate the galleries. The classroom has three large units employing 300-watt Osram lamps.

We understand that the work was carried out by Messrs. E. Wight & Co., Electrical Contractors, of Muswell Hill and Finchley.

PHILIPS LAMPS LIMITED.

FIRST ANNUAL MEETING.

Philips Lamps Limited recently held their first Annual General Meeting, when Captain S. R. Mullard resigned from the Board and the following gentlemen were re-elected and appointed Directors of the Company: A. F. Philips (Dutch) (re-elected); L. G. Sloan, J.P. (British); Sir R. Donald, G.B.E., LL.D. (British); C. J. Powell (British); D. C. F. van Eendenburg (Dutch); and A. de Jong (Dutch). Mr. A. de Jong and Mr. D. C. F. van Eendenburg were appointed Managing Directors.

HALSTED, HANBY & CO. LTD.

CHANGE OF ADDRESS.

Readers are requested to note that Messrs. Halsted, Hanby & Co., the suppliers of the "Restlight" fittings recently referred to in these columns, have changed their address and are now located at 40-43, Norfolk St., Strand, London, W.C.

THE INCANDESCENT MANTLE INDUSTRY IN AUSTRIA.

A recent note in *Licht und Lampe* suggests that the incandescent mantle industry in Austria has fallen on evil days. The industry is largely dependent on certain materials only obtainable from a few localities, for instance ramie yarn, which comes from China, and thoria, which comes from the deposits in Brazil and Travancore. The import of ramie yarn has diminished greatly, being in 1924 only about a quarter what it was in the previous year. This is doubtless due largely to the substitution of synthetic materials. The price of thoria, at one time 60 marks per ton, fell during the war to only 10 marks per ton. It is now largely controlled by the Thorium Syndicate in Berlin, which apparently is once more in control of the European demands.

The large Austrian firms produce about 200 types of mantles. The chief consumers are America (about 60 million) and England (about 40 million). Russia is also an important consumer, though the exact number of mantles taken cannot be stated precisely, and there is also a demand from Jugoslavia and other countries. (The high consumption in England is ascribed to the prevalent foggy and misty weather in this country!)

Exports of mantles have, however, recently fallen very rapidly. In 1924 the output was less than a third what it was in 1923, and the figures up to July 1925 suggested that for that year the exports would be smaller still. Very marked is the diminution in exports to England, which appear to have shrunk to negligible proportions during the first half of 1925. The falling-off in demand has been partly compensated by the smaller number of firms in the business. Before the war there were ten main firms, apart from various small undertakings. To-day there are only three large enterprises. Many factors have contributed towards this change. Some of them may be temporary, but in Austria the position of the mantle industry naturally gives ground for concern.

"EMVEE" LAMPHOLDERS.

A leaflet before us illustrates the "Emvee" lampholders recently introduced by Messrs. Metro-Vick Supplies Ltd. The main feature of these holders is the elimination of the usual weak points arising mainly from the small carrying capacity of plungers and springs, and their comparatively poor contact and flimsy mechanical construction. In the new holder the plungers are solid, and the springs, of phosphor-bronze, are outside; the terminals are at the back of the porcelain, into which they are deeply recessed, and are of substantial construc-

FIG. 1.—Showing Lampholder wired.

FIG. 2.—Sectional view of "Emvee" Lampholder.

tion and readily accessible. It is also stated that the porcelain is much stronger than the usual pattern—an important point, for the annoyance caused by the fracture of the "S" ridge when holders are inadvertently dropped is an old trouble. The current-carrying capacity is substantially increased. The lampholder may seem a small item in a lighting installation, but it is really one on which the whole reliability of electric lighting rests, and this effort to eliminate all sources of weakness is very welcome.

MUNICIPAL LIGHTING.

The most recent issue of *Holophane Illumination* is devoted specially to municipal lighting. In the introduction the variety of problems encountered in lighting public buildings is pointed out. Buildings with historic associations often impose special limitations; in new public buildings the lighting expert has a freer hand. Museums, libraries, swimming baths, washhouses, etc., all present problems of their own. In Courts of Justice good lighting is specially necessary and the cumulative effect of glaring and exposed lights in the range of vision may be anything but favourable to the administration of justice.

The differences in the requirements of reference libraries and reading rooms must be appreciated, but in any case an illumination of 5 foot-candles should be available. In museums and picture-galleries there are additional matters to consider, such as the appearance of coloured objects or canvasses and the avoidance of troublesome shadows and reflections in glass.

The booklet is concluded by a varied series of illustrations of recent Holophane installations, including banqueting halls, courts of justice, offices, libraries, museums, etc.

SIEMENS MONTHLY LIST.

The usual monthly list issued by Messrs. Siemens and English Electric Lamp Co. Ltd., again comes to hand. Important features are the data on standard lamps and enclosed diffusing glassware, moonstone bowls, reflectors, etc. The reverse side of the sheet is devoted to particulars of cables, switches, batteries, etc. We have referred previously to this list as a welcome instance of condensed information.

PHILIPS LAMPS LTD.

NEW BRISTOL ADDRESS.

We are asked to mention that the address of 29, Upper Arcade, Bristol, for Messrs. Philips Lamps Ltd. has now been superseded. The new address is 34, Marsh Street, Bristol.

A

Harcourt Fitting

A TERM that has become synonymous with all that is artistic and effective in the design of Electric Light Fittings.

An immense range of designs of brackets, pendants, standards, electroliers, etc., can be inspected at the branch showrooms of

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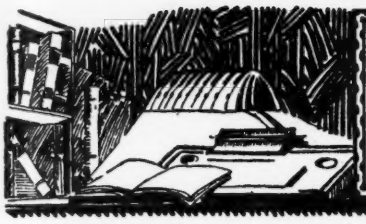

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

A PHYSIOLOGICAL STUDY OF THE VENTILATION AND HEATING IN CERTAIN FACTORS, *by H. M. Vernon and T. Bedford. (Report No. 35, issued by the Industrial Fatigue Research Board. Obtainable from H.M. Stationery Office; price 3s. net.)*

The report contains an account of some careful experiments on atmospheric conditions in a newly built factory provided with natural ventilation and a fan exhaust. It is remarked that natural ventilation systems produced a subjective impression of more freshness than plenum systems, and the air was slightly more humid, though apparently records with hot-wire anemometer and thermopile showed that differences in velocity and temperature were no greater in one case than in the other. Some evidence is adduced to show that the health of workers is influenced by moderate differences in atmospheric conditions. In the introduction the necessity for a careful study of heating and ventilation is emphasized. On such points as the desirable standards of air movement and temperature, differences of opinion may exist, but everyone is agreed that we ought to try to keep the head relatively cool and the feet warm, i.e., to have the air fresher and cooler at head level than at foot level; whereas in actual practice we usually find the reverse conditions of things.

FAN VENTILATION IN A HUMID WEAVING SHED, *by S. Wyatt, J. A. Fraser, and F. G. L. Stock. (Report No. 37 issued by the Industrial Fatigue Research Board, obtainable from H.M. Stationery Office, 1s. 9d. net.)*

The importance of good ventilation in weaving sheds is generally recognized by experts, but nevertheless this is one of those problems where belief has to be supplemented by actual scientific tests in order to carry conviction. The careful research described in the above pamphlet should be of great interest to cotton weavers. The tests leave no doubt of the improved conditions obtainable by suitable installations of fans, and some of the diagrams presented are instructive. It is shown, for example, that the number of loom stoppages due to warp breakages and the actual number of warp threads broken decrease as the relative humidity increases. Temperature has a relatively slight influence in this direction, but it is shown that with a temperature rise from 72 to 85° F. there is a noticeable fall in hourly output. The most striking diagrams are those showing the hourly variations in output on days of high humidity (*a*) with fans running and (*b*) with fans stopped. In the former case output is both at a higher level and better maintained. The whole problem is of special interest in view of the recognition that lighting and ventilating problems in textile mills are closely interlinked. In designing buildings the allocation of window area often resolves itself into a compromise between lighting and ventilation requirements.

(We have also to acknowledge the receipt of "PHOTOMETRY," by JOHN W. T. WALSH, issued by Messrs. Constable & Co., which will be dealt with in our next issue. This book forms an important contribution to literature on photometry, a feature being the very numerous references to papers and articles which have appeared in this country and abroad.—ED.)

INDEX (July, 1926).

EDITORIAL NOTES :—
Research on Illumination—Illuminating Engineering; Its Value to the Contractor—The Study of Colour 187

NOTES AND NEWS ON ILLUMINATION 189

NEWS FROM ABROAD 191

TECHNICAL SECTION :—
Transactions of the Illuminating Engineering Society (Founded in London, 1909):
Research in Illumination; with particular reference to the work of the Illumination Research Committee of the Department of Scientific and Industrial Research, by John W. T. Walsh ... 193
A Critical Study of Modern Developments in the Theory and Technique of Colorimetry and Allied Sciences, by J. Guild 200
National Physical Laboratory; Annual Visit 201
The New Cosmic Rays 202
The Germicidal Action of Ultra-Violet Radiation ... 202

POPULAR AND TRADE SECTION :—
Electric Lamps, Some Notes on: Gasfilled Lamps, by W. J. Jones 203
Glasgow, Lighting Exhibits at 204
Niagara Falls, Floodlighting of... 204
Home, Light in the, by M. Luckiesh 206
High-pressure Gas Lamps, The Lighting-up and Extinguishing of 208
Libraries, Lighting of 210
Farm, The Use of Electric Light on the, by R. Borlase Matthews... 211
Fruit and Flower Culture, The Use of Light in ... 212
Museums, The Lighting of 213
Royal Sanitary Institute: Jubilee Congress 214
Colours, Precautions in Testing of 214
Beckton Gas Works, Visit of Their Majesties The King and Queen to 216

TRADE NOTES 217

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED 219

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